



Pharmacy Information System Implementation, Prescription Efficiency, and Perceived Quality: A Mixed-Methods Study in Palembang Primary Health Centers

Implementasi Sistem Informasi Farmasi, Efisiensi, dan Mutu Pelayanan Resep yang Dipersepsikan: Studi Mixed-Methods di Puskesmas Palembang

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Abstract

The pharmaceutical management information system (SIMF) has the potential to improve the efficiency of prescription services, but the relationship with perceived service quality is influenced by infrastructure readiness, integration, and users. Evidence from Puskesmas that links the level of SIMF implementation with efficiency and quality is still limited. To analyze the relationship between SIMF implementation and the efficiency and quality of prescription services perceived at the Palembang City Health Center and explain the obstacles to implementation. Sequential mixed-methods explanatory research was conducted in six health centers in 2026. Cross-sectional surveys of 18 pharmacists (total sampling) and 96 patients were followed by semi-structured interviews with 6 pharmacists to explain the survey findings. The analysis included descriptive statistics, Shapiro-Wilk tests, Spearman correlation (with simple linear regression as sensitivity analysis), and exploratory MANOVA; interviews were analyzed thematically. High implementation was found in availability and use (94.4%), usefulness (94.4%), and convenience (88.9%), while resources and infrastructure were mainly in the moderate category (77.8%). Wait times ≤ 20 minutes were experienced by 90.6% of patients and 87.5% were very satisfied. Implementation was positively associated with efficiency ($r_s=0.512$; $p=0.030$), but not significantly associated with perceived quality ($r_s=0.404$; $p=0.097$); inconclusive due to limited testing power). Interviews showed that data flow and prescribing readability improved, but unstable connections, limited computers, double record-keeping, absence of clinical decision support, and uneven training still occurred. Higher implementation of SIMF was associated with better operational efficiency, but was not significantly associated with perceived quality (inconclusive due to limited testing power); interviews indicated that quality may be limited by sociotechnical gaps and integration. Strengthening infrastructure, interoperability, clinical decision support, and ongoing training are needed.

Abstrak

Sistem informasi manajemen farmasi (SIMF) berpotensi meningkatkan efisiensi pelayanan resep, tetapi hubungannya dengan mutu pelayanan yang dipersepsikan dipengaruhi kesiapan infrastruktur, integrasi, dan pengguna. Bukti dari Puskesmas yang menghubungkan tingkat implementasi SIMF dengan efisiensi sekaligus mutu masih terbatas. Tujuan: Menganalisis hubungan implementasi SIMF dengan efisiensi dan mutu pelayanan resep yang dipersepsikan di Puskesmas Kota Palembang serta menjelaskan hambatan implementasinya. Penelitian mixed-methods explanatory sequential dilakukan di enam Puskesmas pada tahun 2026. Survei potong lintang terhadap 18 tenaga kefarmasian (total sampling) dan 96 pasien dilanjutkan wawancara semi-terstruktur dengan 6 apoteker untuk menjelaskan temuan survei. Analisis mencakup statistik deskriptif, uji Shapiro-Wilk, korelasi Spearman (dengan regresi linear sederhana sebagai analisis sensitivitas), dan MANOVA eksploratif; wawancara dianalisis secara tematik. Implementasi tinggi ditemukan pada ketersediaan dan penggunaan (94,4%), kemanfaatan (94,4%), dan kemudahan (88,9%), sedangkan sumber daya dan sarana-prasarana terutama berkategori sedang (77,8%). Waktu tunggu ≤ 20 menit dialami 90,6% pasien dan 87,5% sangat puas. Implementasi berhubungan positif dengan efisiensi ($r_s=0,512$; $p=0,030$), tetapi tidak berhubungan signifikan dengan mutu yang dipersepsikan ($r_s=0,404$; $p=0,097$); tidak konklusif karena daya uji terbatas. Wawancara menunjukkan aliran data dan keterbacaan resep membaik, namun koneksi tidak stabil, komputer terbatas, pencatatan ganda, ketiadaan dukungan

keputusan klinis, dan pelatihan tidak merata masih terjadi. Implementasi SIMF yang lebih tinggi berhubungan dengan efisiensi operasional yang lebih baik, tetapi tidak berhubungan signifikan dengan mutu yang dipersepsikan (tidak konklusif karena daya uji terbatas); wawancara mengindikasikan bahwa mutu mungkin dibatasi kesenjangan sosioteknis dan integrasi. Penguatan infrastruktur, interoperabilitas, dukungan keputusan klinis, dan pelatihan berkelanjutan diperlukan.

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INTRODUCTION

Pharmaceutical services at Puskesmas are an integral part of primary health services and must ensure safe, high-quality, and patient-oriented management of pharmaceutical preparations and clinical pharmacy services¹. Administrative burdens, the need for drug traceability, reporting demands, and the risk of incomplete prescriptions make the pharmacy management information system (SIMF) increasingly important. In Indonesia, information integration has been regarded as a strategy to strengthen the role of pharmacists in primary care, support drug management, and improve the completeness of prescription screening²⁻⁴.

Implementing a SIMF means more than making software available. Studies in hospitals and pharmaceutical facilities show that its benefits depend on fit with workflow, ease of use, human-resource capacity, organizational support, and infrastructure⁵⁻⁷. The Technology Acceptance Model explains that perceived usefulness and ease of use influence technology acceptance, while the information systems success model adds system quality, information quality, use, user satisfaction, and net benefits as interrelated dimensions^{8,9}. The Unified Theory of Acceptance and Use of Technology emphasizes performance expectancy, effort expectancy, social influence, and facilitating conditions^{10,11}.

In complex health systems, digitalization is also sociotechnical. The NASSS framework, the eight-dimensional sociotechnical model, and the human-factors approach show that technology interacts with people, organizations, processes, policies, and the physical environment¹²⁻¹⁴. Clinical features such as decision support, interoperability, interface design, and update governance are therefore as important as application availability^{15,16}.

Electronic prescriptions can improve legibility and reduce some errors, but may also produce new errors, communication breakdowns, and additional work steps when the design does not match practice¹⁷⁻²². Systematic reviews show that the effects on communication, working time, clinical flow, and workarounds can be both positive and negative.^{23,24} Computer-based interventions are effective for several types of medication error, yet overall results remain heterogeneous and context-dependent²⁵⁻²⁹. In Indonesia, electronic prescribing has been linked to improved medication safety, while clinical decision support for drug interactions still requires development^{30,31}.

Prescription-service efficiency can be observed through waiting time, smoothness of data flow, recording burden, and reporting speed. Service quality is broader, encompassing accuracy, safety, communication, information availability, and patient experience. Verified drug information and cross-facility data exchange are prerequisites for digital quality.^{32,33}

Research gap. Existing evidence falls into three groups: (i) international studies of electronic prescribing that examine error rates, workflow, and pharmacist experience, mostly in hospitals and community pharmacies;¹⁷⁻²⁹ (ii) Indonesian studies on system design, needs assessment, and determinants of implementation, mostly in hospitals;^{2-5,49} and (iii) Indonesian studies of waiting time and satisfaction in Puskesmas pharmacies, which do not assess the level of

information-system implementation.^{46–48} To our knowledge, few studies have examined, within Puskesmas, how the level of SIMF implementation is related to both prescription-service efficiency and perceived quality while also explaining the barriers from the perspective of the personnel who operate the system. Without this evidence, managers cannot tell whether investment in a SIMF alone is sufficient to improve quality, or whether supporting infrastructure, integration, and training must be addressed at the same time.

This study therefore aimed to (1) describe the level of SIMF implementation, waiting time, and patient satisfaction; (2) analyze the association of SIMF implementation with prescription-service efficiency and perceived quality in six Palembang City Puskesmas; and (3) explain implementation barriers from the perspective of pharmacy personnel.

METHODS

Design and rationale

We used an explanatory sequential mixed-methods design (quantitative → qualitative). This design was chosen because the quantitative question (is the level of implementation associated with efficiency and quality, and how large is the association?) could be answered by a survey, whereas the reasons why implementation might be associated with some outcomes but not others could not be captured by numbers alone and required the users' own accounts. In the first phase, a cross-sectional survey measured implementation, efficiency, quality, waiting time, and satisfaction. In the second phase, semi-structured interviews were used to explain the survey results.

Connection between phases. The survey results determined what was explored in the interviews: (a) the contrast between high perceived usefulness and only moderate human-resource and infrastructure support, (b) the significant association with efficiency but not with quality, and (c) the very high patient satisfaction despite moderate quality scores. The interview guide covered benefits, workflow, infrastructure, training, and system constraints. The two data sets were integrated at the interpretation stage using a joint display (Table 7). The survey was carried out in June – July 2026 and interviews in August 2026, i.e., 3 weeks after the survey was completed.

The study was conducted at Puskesmas 4 Ulu, Plaju, Opi, Dempo, Sekip, and Nagaswidak in Palembang in 2026. Sites were selected purposively to represent variation in SIMF use in primary services.

Population and sample

Quantitative phase. All 18 pharmacy personnel who met the inclusion criteria in the six Puskesmas were included (total sampling). Patient respondents numbered 96, i.e., 16 per Puskesmas, selected by accidental sampling. Patients were aged ≥ 17 years, had completed the prescription-service process, and were willing to participate.

Sample adequacy. The pharmacy-personnel sample was a census of eligible staff and therefore limited by the small population, not by choice. Sensitivity analysis for a two-tailed correlation test ($n=18$, $\alpha=0.05$) shows that 80% power is reached only for large associations ($|r| \geq 0.58$, i.e., $R^2 \geq 0.34$). The observed Spearman association for efficiency ($r_s=0.512$; $r_s^2=0.262$) had an approximate post hoc power of ≈ 0.66 , whereas that for quality ($r_s=0.404$; $r_s^2=0.163$) had only ≈ 0.42 (approximated from the power of a correlation test for the same n and α). The non-significant result for quality must therefore be read as inconclusive rather than as evidence of no association (see Limitations). The patient sample ($n=96$) was used only for descriptive outcomes.

Qualitative phase. Interview participants were selected purposively from the survey respondents using the following criteria: being a pharmacist directly involved in operating the SIMF, familiarity with the prescription-service flow, having at least 6 months of experience with the system, and representation of each Puskesmas (one participant per site). A

total of 6 participants were interviewed, all of them pharmacists, one from each of the six Puskesmas. Recruitment continued until all planned participants were interviewed.

Variables and instruments

The independent variable was SIMF implementation, comprising availability and use, ease of use, usefulness, and human resources and facilities. The dependent variables were prescription-service efficiency and quality as perceived by pharmacy personnel. Patient outcomes were waiting-time category and satisfaction. The initial pharmacy-personnel questionnaire had 48 items; two failed the validity test, leaving 46 valid items. The patient questionnaire had 15 items. Scores were categorized as low, medium, or high using mean.

Validity, reliability, and data collection

Item validity was assessed using the corrected item-total Pearson correlation. The critical value (r -table) was 0.361, corresponding to $\alpha = 0.05$ (two-tailed) and $df = 28$; this was based on a pilot sample size of $n = 30$ for the patient satisfaction questionnaire regarding services at the Plaju Community Health Center (Puskesmas), which has an average of 85 patient visits per day. This sample is different from the previous study. All 15 patient items were valid ($r=0.740$ – 0.905). Items D7 and E5 of the pharmacy-personnel instrument were invalid and removed. Internal consistency was very high (Cronbach's alpha 0.981 for the 46 pharmacy-personnel items and 0.962 for the 15 patient items; ≥ 0.70 was considered acceptable). Quantitative data were collected by questionnaire and service-time recording. Interviews were semi-structured, lasted approximately 30 minutes, were audio-recorded with consent, and transcribed verbatim.

Data analysis

Quantitative data were presented as frequencies and percentages. Normality of scores was checked with the Shapiro–Wilk test. Because efficiency and quality scores were not normally distributed and $n=18$, the association of SIMF implementation with efficiency and quality was examined primarily with Spearman's rank correlation (r_s ; two-tailed, $\alpha=0.05$). As a sensitivity analysis, simple linear regression was also fitted to obtain unstandardized (B) and standardized (β) coefficients; because normality of residuals is difficult to verify with $n=18$, regression estimates are interpreted cautiously. Multivariate analysis using Pillai's trace MANOVA was exploratory. Because the 18 personnel were nested within six Puskesmas (about three per site), observations may not be independent and p -values are interpreted cautiously. Due to the cross-sectional design, the results are interpreted as associations, not causal effects.

Interview transcripts were analyzed thematically: familiarization, open coding, grouping of codes into categories, and development of themes that explain the quantitative results. Coding was performed by A.U.P., and disagreements were resolved by N.A. Otter.ai was used to support transcription.

Research ethics

The study was approved by the research ethics committee (No. 004681/KEP/STIKES MITRA ADIGUNA/2026). All respondents gave consent after receiving an explanation, and data confidentiality was maintained.

RESULT AND DISCUSSION

Karakteristik responden

Most patients were aged ≥ 47 years (66.7%), female (80.2%), high-school educated (49.0%), and housewives (49.0%) (Table 1). All pharmacy personnel were women; two-thirds had a D-III education and worked as pharmaceutical vocational personnel, and more than half had worked for five years or less (Table 2). This composition matters because experience, profession, and exposure to training can affect perceived ease of use and adaptability to the system.

Table 1. Characteristics of patients receiving prescription services (n=96)

Variable	Category	n (%)
Age	17-31 years old	10 (10.4)
	32-46 years old	22 (22.9)
	47-61 years old	32 (33.3)
	≥62 years old	32 (33.3)
Gender	Male	19 (19.8)
	Women	77 (80.2)
Education	No school	2 (2.1)
	SD	12 (12.5)
	SMP	18 (18.8)
	SMA	47 (49.0)
	Colleges	17 (17.7)
Jobs	Not working	28 (29.2)
	Housewives	47 (49.0)
	Private	14 (14.6)
	Labor	4 (4.2)
	Civil servants	3 (3.1)

Table 2. Characteristics of pharmaceutical personnel (n=18)

Variable	Category	n (%)
Gender	Women	18 (100)
Education	D-III	12 (66.7)
	S-1 Profession	5 (27.8)
	S-2 Profession	1 (5.6)
Profession	Pharmacist	6 (33.3)
	Pharmaceutical vocational personnel	12 (66.7)
Age	≤35 years old	7 (38.9)
	36-45 years old	8 (44.4)
	46-55 years old	2 (11.1)
	>55 years old	1 (5.6)
Working period	≤5 years old	10 (55.6)
	6-10 years	3 (16.7)
	11-20 years	3 (16.7)
	>20 years	2 (11.1)

Waiting time and patient satisfaction

A total of 87 patients (90.6%) received their medication in 20 minutes or less, and only one patient (1.0%) waited more than 30 minutes. Eighty-four patients (87.5%) were very satisfied, and none was dissatisfied or very dissatisfied (Table 3). Waiting time is easy for patients to observe and is often related to satisfaction, but satisfaction is also shaped by communication, comfort, drug availability, and expectations.^{34–39} Questionnaire validation studies in pharmaceutical services likewise emphasize measuring patient experience multidimensionally rather than by speed alone^{40–44}.

Table 3. Wait time and patient satisfaction (n=96)

Variable	Category	n (%)
Waiting time	<10 minutes	31 (32.3)
	11-20 minutes	56 (58.3)
	21-30 minutes	8 (8.3)
	>30 minutes	1 (1.0)
Satisfaction	Very dissatisfied	0 (0)
	Dissatisfied	0 (0)
	Quite satisfied	3 (3.1)
	Satisfied	9 (9.4)
	Very satisfied	84 (87.5)

Implementation level, efficiency, and quality

Implementation was rated high for availability and use (94.4%), usefulness (94.4%), and ease of use (88.9%). In contrast, human resources and infrastructure were mostly in the medium category (77.8%), with one respondent in the low category. Efficiency was mainly medium (66.7%), while quality was evenly split between medium and high (Table 4). This pattern is consistent with technology-acceptance theory: users may find the system useful and reasonably easy to use, yet actual benefits remain limited by facilitating conditions⁸⁻¹¹.

Table 4. Categories of SIMF implementation, efficiency, and quality (n=18)

Dimensions/exterior	Category	n (%)
Availability and use	Low	0 (0)
	Medium	1 (5.6)
	High	17 (94.4)
Ease of use	Low	0 (0)
	Medium	2 (11.1)
	High	16 (88.9)
Usefulness	Low	0 (0)
	Medium	1 (5.6)
	High	17 (94.4)
Human Resources and Facilities	Low	1 (5.6)
	Medium	14 (77.8)
	High	3 (16.7)
Efficiency	Low	0 (0)
	Medium	12 (66.7)
	High	6 (33.3)
Quality	Low	0 (0)
	Medium	9 (50.0)
	Hig.	9 (50.0)

Instrument quality and analysis assumptions

Reliability of both instruments was very high. However, only the implementation score met the normality assumption ($p=0.056$); quality ($p=0.006$) and efficiency ($p=0.013$) scores were not normally distributed (Table 5). With $n=18$, this reinforces the need for cautious interpretation and confirmation in larger samples. Accordingly, Spearman's rank correlation was used as the primary analysis, and regression estimates are reported only as a sensitivity analysis. Two items of the pharmacy-personnel instrument (D7 and E5) were invalid and removed; reliability was therefore reported for 46 rather than 48 items..

Table 5. Summary of instrument quality and normality test

Components	Quantity	Test	Results	Interpretation
Pharmaceutical personnel questionnaire	46 valid items	Cronbach alpha	0.981	Reliable
Patient questionnaire	15 valid items	Cronbach alpha	0.962	Reliable
Implementation score	n=18	Shapiro-Wilk	W=0.899; p=0.056	Normal
Quality score	n=18	Shapiro-Wilk	W=0.838; p=0.006	Not normal
Efficiency score	n=18	Shapiro-Wilk	W=0.861; p=0.013	Not normal

Association of SIMF implementation with efficiency and quality

SIMF implementation was positively and significantly associated with prescription-service efficiency ($r_s=0.512$; $p=0.030$). The association with perceived quality was also positive but not statistically significant ($r_s=0.404$; $p=0.097$) (Table 6). Thus, the data support an association between implementation and operational efficiency but do not show a significant association with perceived quality. Given the limited power for the quality association (≈ 0.42), this finding is inconclusive rather than evidence of no association. In the sensitivity analysis using simple linear regression, the direction of both associations was the same: implementation was significantly associated with efficiency ($B=0.159$; $\beta=0.759$; $p<0.001$) and non-significantly with quality ($B=0.065$; $\beta=0.348$; $p=0.157$). The regression estimate for efficiency is noticeably stronger than the rank-based one, which may reflect the influence of extreme scores or the non-normal distribution in this small sample; the rank-based estimate is therefore regarded as the more conservative one. The exploratory MANOVA (Pillai's trace=0.614; $F(4, 30)=3.326$; $p=0.023$) indicated an overall multivariate difference in the combined efficiency and quality outcomes across the groups analyzed; because of the small sample and non-normal outcome distributions, it is interpreted as exploratory only.

This difference is plausible. A SIMF can speed up data retrieval, reporting, and administrative processes before it can improve more complex clinical aspects. International implementation experience shows that improvements in timeliness and safety require workflow design, server stability, interoperability, and adequate staffing^{22,24,27,34,36-39}. In Indonesia, queue digitization can also reduce waiting times, but results remain influenced by user adoption and facility readiness⁴⁵. Another local study found a relationship between waiting time and satisfaction, although it varied between facilities⁴⁶⁻⁴⁸.

Table 6. Spearman's rank correlation and exploratory multivariate analysis (MANOVA)

Analysis	Parameter	rs/ Pillai's trace	F(df)	N	P	Remarks
Spearman's rho correlation	Implementation of SIMF → Prescription Service Efficiency	0.512	-	18	0.030	Significant
Spearman's rho correlation	Implementation of SIMF → Prescription Service Quality	0.404	-	18	0.097	Not Significant
Exploratory MANOVA	Pillai's trace	0.614	$F(4,30) = 3.326$	18	0.023	Significant

rs=Spearman's rank correlation coefficient. MANOVA is listed as exploratory because of the small sample size and the non-normal distribution of the efficiency and quality scores. Regression estimates (sensitivity analysis) are reported in the text.

Qualitative findings and sociotechnical explanations

Interviews were held with 6 pharmacists, from 6 Puskesmas. Four themes emerged. Participants are identified by profession and Puskesmas; quotations were translated from Indonesian.

Theme 1: Operational benefits. Digital prescriptions were considered easier to read, reduced handwriting problems, sped up information flow, and helped reporting. *“you no longer have to decipher the handwriting, it is just clear right away; paper prescriptions are usually unreadable”* (Pharmacist, Puskesmas Nagaswidak). These findings agree with evidence that electronic systems can reduce legibility-related errors and improve process efficiency, although they do not eliminate all error types.^{22,24,30}

Theme 2: Infrastructure and integration limits. In some sites only one official computer was available, so staff used laptops, tablets, mobile phones, or personal data plans. Network and server disruptions, system freezes at peak hours, and retrospective data entry encouraged hybrid flows. In two Puskesmas, some dispensing and documentation processes were completed manually first and entered into the system later. Stock cards and physical logbooks were maintained, resulting in duplicate recording. The lack of thermal label printers also limited standardization of drug labeling. *“Actually it is not enough, because there is only one. So each of us brings our own; there are three of us, and sometimes each brings a laptop”* (Pharmacist, Puskesmas Dempo). Such risks have been described in studies of poor integration, unintended consequences of pharmacy systems, and workarounds in health-technology implementation.^{27,28}

Theme 3: Limited clinical functions. The system did not adequately provide clinical decision support for allergy screening, therapy duplication, dosing, or drug interactions. Consequently, any effect on clinical quality depended on manual screening and interprofessional communication. *“I think screening features should be added to the system because they are currently unavailable, and they are greatly needed in practice”* (Pharmacist, Puskesmas Plaju). Decision support can strengthen therapeutic accuracy but requires complete data, appropriate algorithms, alert governance, and integration with patient records.^{15,31–33}

Theme 4: Training and staff resilience. Training was mostly given at the start of implementation and targeted pharmacists, while vocational personnel often learned through peer transfer. Staff commitment kept services running when networks or devices failed, but reliance on personal devices and improvisation is not a sustainable solution. *“To keep operations running smoothly, we sometimes have to rely on our own Wi-Fi”* (Pharmacist, Puskesmas Nagaswidak). Experience with hospital information systems in Indonesia also shows that benefits do not arise automatically because use is mandatory; support quality, task fit, and user engagement remain decisive.⁴⁹ The high patient satisfaction in this study should be read together with the facility limitations and the non-significant quality result. Studies of pharmaceutical services in other Puskesmas also identify reliability, responsiveness, and physical evidence as important components of satisfaction.^{48,50}

Integration of quantitative and qualitative findings

Table 7 shows how the interview themes explain the survey results.

Table 7. Joint display of quantitative findings and qualitative explanations

Quantitative finding	Qualitative explanation	Integrated interpretation
High usefulness (94.4%) and ease of use (88.9%)	Theme 1: legible prescriptions, faster data flow, easier reporting	Perceived benefits are concentrated in administrative and data-handling tasks
Significant association with efficiency ($r_s=0.512$; $p=0.030$), yet efficiency mostly medium (66.7%)	Theme 2: shared computers, unstable network/server, hybrid manual flow, duplicate recording	Higher implementation is associated with better efficiency, but infrastructure gaps may cap the gain
No significant association with quality ($r_s=0.404$; $p=0.097$)	Theme 3: no decision support for allergy, duplication, dose, interaction; reliance on manual screening	Quality is not directly supported by the system as currently configured; low power also limits inference
87.5% very satisfied despite mostly medium efficiency and quality that was only half high	Theme 4: uneven training; service maintained by staff improvisation	Satisfaction likely reflects factors beyond system quality (e.g., staff effort, courtesy bias)

Practical implications

Recommendations are grouped by implementation horizon.

Short term (0–6 months): actions within Puskesmas and district authority

- Provide at least one adequate work device at each critical point (registration, dispensing) and official backup internet connections.
- Set up downtime monitoring and a written downtime procedure, with simulations for when the system is unavailable.
- Provide label printers and define technical support with clear response times.
- Start role-based refresher training that includes both pharmacists and vocational personnel.

Long term (>6–12 months): system development and governance

- Integrate prescriptions, stock, patient history, and reporting, and remove unnecessary duplicate records.
- Introduce clinical screening in stages (allergy, therapy duplication, dose, then drug interactions) with alert governance.
- Institutionalize iterative training and onboarding.

Adopt evaluation indicators: actual waiting time, prescription completeness and accuracy, medication errors, satisfaction, workload, downtime, and proportion of processes still done manually.

Limitation

This study was cross-sectional and can show associations only, not causation. It involved 18 pharmacy personnel from six Puskesmas selected purposively, which may introduce selection bias: sites and interviewees may differ from other Puskesmas or from personnel who were less engaged with the system, limiting transferability. The small sample gave low power for the quality model and made estimates imprecise. The 18 personnel were nested within six Puskesmas (about three per site) and this clustering was not modelled, so observations may not be independent and p-values may be optimistic. Most implementation, efficiency, and quality measures were based on respondents' perceptions, and the clinical quality of prescriptions was not verified. The very high patient satisfaction may reflect courtesy bias, timing of measurement, and respondent characteristics. Future research should use larger and

probability-based samples, longitudinal or before–after designs, standardized prescription audits, automated time logs, and robust analyses that account for differences between Puskesmas.

CONCLUSION

Among 18 pharmacy personnel in six Palembang Puskesmas, SIMF implementation was rated high for availability, use, ease of use, and usefulness, but resource and facility support remained moderate. Implementation was positively associated with prescription-service efficiency ($r_s=0.512$; $p=0.030$) but not significantly with perceived quality ($r_s=0.404$; $p=0.097$; inconclusive given limited power). Most patients (90.6%) received medication in 20 minutes or less and 87.5% were very satisfied. Interviews suggested that infrastructure limits, duplicate recording, absent clinical decision support, and uneven training may explain why implementation was not clearly linked to perceived quality, although this remains inconclusive. Strengthening these elements may be needed for digital efficiency to translate into measurable quality and safety improvements.

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AUTHOR CONTRIBUTION STATEMENT (Calibri, 12 pt)

Conceptualization: N.A.; methodology: N.A. and A.U.P.; investigation: R.D., P.M., and E.N.A.; formal analysis: N.A. and A.U.P.; data curation: P.M. and E.N.A.; supervision: N.A.; writing—original draft: N.A. and A.U.P.; writing—review and editing: all authors.

CONFLICT OF INTEREST DECLARATION

The authors declare no conflict of interest related to this research and publication.

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