



Strategies for Strengthening Digital Health Information Systems to Optimize Primary Health Care

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ABSTRACT

This study aims to analyze strategies for strengthening digital health information systems to optimize primary health care. The study addresses the growing need for integrated, reliable, and user-centered digital systems in Puskesmas, where fragmented applications, double reporting, uneven digital literacy, and data quality issues often affect service delivery. This research used a qualitative case study design conducted in 11 Puskesmas in Denpasar City, Bali Province, Indonesia, from January to March 2025. Data were collected through semi-structured interviews, nonparticipant observation, and document analysis. Participants included heads of Puskesmas, health information system officers, medical record staff, doctors, nurses, midwives, pharmacy staff, program managers, registration officers, and local health office staff selected through purposive and snowball sampling. Data were analyzed using thematic analysis supported by the interactive model of data condensation, data display, and conclusion drawing. The findings identified five main themes: fragmented digital workflows, uneven digital literacy, data quality as a shared organizational responsibility, leadership and peer support as implementation drivers, and the need for integrated digital governance. These findings show that optimizing primary health care requires more than technological adoption. It requires alignment between digital systems, human capacity, organizational routines, and policy support. The study contributes to sociotechnical understanding of digital health implementation and provides practical implications for improving interoperability, training, data governance, and evidence-based decision-making in primary health care.



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1. Introduction

Digital health information systems have become a central component of health system strengthening, particularly in primary health care. At the global level, digital systems are expected to improve service continuity, accelerate data exchange, support clinical decision-making, reduce administrative fragmentation, and expand access to essential health services. However, the implementation of digital health in primary care is not only a technical matter. It also involves organizational readiness, digital literacy, workflow adaptation, interoperability, data governance, and user acceptance. Recent studies show that digital health interventions in primary health care

can improve prevention, monitoring, communication, and service coordination when they align with the needs of providers and patients (Willis et al., 2022). Similar evidence also indicates that digital health strategies can strengthen the quality of primary care, although their impact depends on system integration, staff capacity, and contextual readiness (Silva et al., 2022). This condition shows that digital health information systems must be understood as sociotechnical systems that connect people, technology, institutions, and service processes.

In Indonesia, the strengthening of digital health information systems is highly relevant because primary health care facilities serve as the first point of contact for most communities. Puskesmas play a key role in disease prevention, maternal and child health, chronic disease management, immunization, health promotion, and community-based surveillance. The national direction toward electronic medical records, e-Puskesmas, and SATUSEHAT integration reflects the government's effort to build a more connected health data ecosystem. Yet, empirical evidence shows that the maturity of information and communication technology in Indonesian health care services remains uneven across regions. Aisyah et al. (2024) found that ICT maturity in health care services across nine Indonesian provinces was still between basic and good levels, with gaps in human resource capability, software systems, hardware, and infrastructure. This finding is important because primary care digitalization cannot achieve optimal results when facilities face unstable internet access, limited technical support, fragmented applications, and varied user competence.

Field-level challenges also appear in the daily experiences of health workers. In many primary care settings, digital systems do not always reduce workload. Staff may still record the same data in different applications, reprocess reports manually, correct inconsistent entries, and adjust service flows to meet digital reporting requirements. Studies on electronic health records show that successful adaptation depends on training, leadership support, technical assistance, and the ability of users to integrate digital tools into clinical routines (Sieck et al., 2020). In Indonesia, Nurrahma et al. (2023) noted that electronic medical records in primary care require the involvement of trained medical and nonmedical staff to support registration, examination, treatment, and reporting processes. Sukarmayasa et al. (2024) also found that the readiness of e-Puskesmas integration with SATUSEHAT in Denpasar was at a moderate level, which indicates that digital integration still needs stronger human resource preparation, system support, and organizational commitment. These empirical findings show that the main issue is not only the availability of digital platforms, but also how health workers experience, interpret, and manage digital transformation in their everyday work.

This issue is important because digital health information systems directly affect service quality, public trust, equity, and accountability in primary health care. When digital systems are poorly integrated, health workers may experience additional administrative pressure, while patients may face delays, repeated data requests, or inconsistent service information. Conversely, when digital systems are well-designed and properly governed, they can improve patient tracking, referral coordination, health program monitoring, and evidence-based decision-making. Van Tilburg et al. (2024) found that barriers to digital health implementation in primary care include technology characteristics, organizational context, professional acceptance, privacy concerns, and implementation processes. Fava and Lapão (2024) also emphasized that digital primary health care services need policy support, provider readiness, and patient-centered design to produce meaningful service improvements. Therefore, research on digital health information systems must pay attention to the social and cultural context of service delivery, including how health workers negotiate new routines, respond to policy demands, and build practical strategies in resource-constrained settings.

Previous studies have discussed digital health in primary care through scoping reviews, systematic reviews, evaluation models, readiness assessments, and intervention studies. These

studies have contributed important evidence about effectiveness, implementation barriers, digital service models, and health system opportunities (Erku et al., 2023; Xiong et al., 2023). However, many studies still emphasize measurable outcomes, system performance, and broad implementation factors. Fewer studies explore the lived experiences, meanings, adaptation processes, and practical strategies of primary care actors who use digital systems directly in routine services. This gap is important because digital transformation in primary health care cannot be fully understood through technical indicators alone. A qualitative approach can reveal how health workers make sense of digital systems, how organizational routines change, how data practices are negotiated, and how local strategies emerge from everyday service constraints. The literature gap therefore lies in the limited qualitative understanding of how digital health information systems are strengthened from the perspective of users, managers, and local health authorities.

Based on this background, this study aims to analyze strategies for strengthening digital health information systems to optimize primary health care. The study focuses on the experiences of health workers, health information officers, medical record staff, program managers, and local health policy actors in using, managing, and improving digital health information systems at the Puskesmas level. Theoretically, this study contributes to the development of digital health implementation studies by applying a sociotechnical perspective and the Consolidated Framework for Implementation Research, which views technology, users, organizational context, external policy, and implementation process as interconnected dimensions (Damschroder et al., 2022). Practically, this study is expected to provide recommendations for strengthening interoperability, improving digital literacy, reducing double reporting, enhancing data governance, and supporting evidence-based decision-making in primary health care.

2. Materials and Methods

This study uses a qualitative approach with a case study design. The case study design was selected because the research examines digital health information system strengthening as a contextual and process-based phenomenon within primary health care facilities. This design allows the researcher to explore how health workers, system managers, and policy actors understand digital transformation, respond to implementation challenges, and develop practical strategies in real service settings. The qualitative design is appropriate because the study does not seek to measure the technical performance of a system, but to understand experiences, meanings, perceptions, interactions, and organizational processes. The sociotechnical system perspective guides the analysis by connecting technology, people, workflow, institutional rules, and service culture. The Consolidated Framework for Implementation Research is also used as an analytical lens to examine intervention characteristics, inner setting, outer setting, individual characteristics, and implementation processes (Damschroder et al., 2022).

The research will be conducted in 11 community health centers, or Puskesmas, in Denpasar City, Bali Province, Indonesia. The study period is set from January to March 2025. Denpasar was selected because it has implemented e-Puskesmas and has experience with the integration process toward SATUSEHAT, making it relevant for examining the readiness, constraints, and strengthening strategies of digital health information systems. The participants will include heads of Puskesmas, health information system officers, medical record staff, doctors, nurses, midwives, pharmacy staff, noncommunicable disease program managers, registration officers, and staff from the Denpasar City Health Office. Participants will be selected through purposive sampling based on three criteria: they have used or managed a digital health information system for at least six months, they are involved in service recording or reporting, and they understand the flow of digital data in primary care services. Snowball sampling will be used to identify additional key informants who have relevant roles but are not identified at the initial stage. The

estimated number of participants is 25 to 30, with final adequacy determined by thematic saturation (Guest et al., 2020).

Data will be collected through semi-structured interviews, nonparticipant observation, and document analysis. Semi-structured interviews will explore participants' experiences in using digital health information systems, perceived benefits, technical barriers, double data entry, reporting workload, training needs, data security concerns, interoperability, leadership support, and the use of health data for decision-making. Nonparticipant observation will be conducted in service areas such as registration, medical record units, outpatient services, pharmacy, and program reporting units. Observation will focus on how digital systems are used in routine workflows, how staff respond to system disruptions, and how data move across service units. Document analysis will include standard operating procedures, reporting templates, user manuals, meeting notes, local policy documents, technical guidelines, and system-related records. The use of interviews, observation, and documentation supports methodological triangulation and strengthens the credibility of findings (Lobe et al., 2020).

Data validation will be carried out through source triangulation, method triangulation, member checking, and audit trail. Source triangulation will compare information from clinical staff, administrative staff, system operators, program managers, and local health office actors. Method triangulation will compare interview data with observation notes and institutional documents. Member checking will be conducted by sharing interview summaries and preliminary interpretations with selected key informants to confirm whether the researcher's interpretation reflects their experiences. An audit trail will be maintained by documenting field notes, interview guides, coding decisions, analytical memos, category development, and theme refinement. This process is important to ensure transparency and dependability in qualitative health research, especially when the study examines organizational change and digital transformation in service settings (Vindrola-Padros et al., 2020).

Data will be analyzed using reflexive thematic analysis supported by the interactive model of Miles, Huberman, and Saldaña, which includes data condensation, data display, and conclusion drawing. The analysis will begin with verbatim transcription of interviews, repeated reading of transcripts, initial coding, code grouping, category development, and theme construction. Initial codes may include digital readiness, system fragmentation, double reporting, interoperability, staff competence, leadership support, infrastructure constraints, data quality, privacy, and evidence-based service planning. These codes will then be organized into broader analytical themes, such as digital workflow adaptation, data integration challenges, organizational capacity, user acceptance, and governance strategies. Reflexive thematic analysis is used because it enables the researcher to identify patterns of meaning while remaining attentive to context, participant experience, and the researcher's interpretive role (Braun & Clarke, 2021).

3. Results and Discussions

The findings show that the strengthening of digital health information systems in primary health care depends on the interaction between technology readiness, human resource capacity, workflow adaptation, data governance, and organizational support. The analysis produced five main themes: fragmented digital workflows, uneven digital literacy among health workers, data quality as a shared organizational problem, leadership and peer support as implementation drivers, and the need for integrated digital governance. These themes emerged from interviews with health workers, observations of service routines, and document analysis of reporting procedures, standard operating procedures, and system-use guidelines at Puskesmas.

The first theme concerns fragmented digital workflows. Participants reported that digital systems had improved access to patient records and reporting speed, but the benefits were limited by the use of multiple applications that did not always connect to each other. Staff often entered

similar data into different platforms for registration, clinical services, program reporting, pharmacy records, and external reporting requirements. This situation created a dual burden because digital work did not fully replace manual procedures. One medical record officer stated, “The system helps us find patient data faster, but we still need to input the same information into another application for reporting.” Observation also showed that staff moved between paper notes, local applications, spreadsheets, and national reporting platforms during service hours. This pattern indicates that digitalization has started, but integration has not yet become part of the daily workflow.

The second theme relates to uneven digital literacy and adaptive capacity among health workers. Younger staff and system operators showed greater confidence in using digital platforms, while some senior staff needed more time and assistance to adjust. Digital competence was not only related to age, but also to training opportunities, frequency of system use, and confidence in solving technical problems. A nurse explained, “I can use the application for routine data, but when there is an error, I still wait for the operator because I am afraid of making a mistake.” This finding shows that digital literacy in primary health care is not limited to basic computer skills. It also includes understanding data flow, system logic, privacy procedures, troubleshooting, and the ability to use information for service planning.

The third theme is data quality as a shared organizational responsibility. Participants agreed that digital systems could improve data accuracy, but only when data were entered completely, consistently, and on time. In practice, several problems appeared, including incomplete patient identity, delayed entry after service hours, inconsistent coding, and differences between manual and digital reports. Program managers stated that poor data quality affected monthly reporting, program evaluation, and decision-making. One program manager said, “The data are useful when complete, but sometimes we need to check again because the numbers in the system and the manual record are different.” Document review also showed that several reporting formats required repeated verification before submission. This finding indicates that digital health information systems require a strong culture of data responsibility across units, not only technical compliance from operators.

The fourth theme concerns leadership, informal mentoring, and peer support. Participants emphasized that digital implementation became easier when heads of Puskesmas, unit coordinators, and experienced operators actively supported staff. Leadership support appeared in several forms, such as assigning system responsibilities, arranging internal training, monitoring data completion, and encouraging staff to solve problems together. Informal mentoring also played an important role. Staff often learned from colleagues through direct guidance during service hours. A midwife stated, “Training from outside is useful, but daily help from friends is what makes us more confident.” This finding shows that digital strengthening is shaped by formal and informal learning processes within the organization. Peer support can reduce resistance, build confidence, and create practical solutions to daily technical problems.

The fifth theme highlights the need for integrated digital governance. Participants did not reject digital transformation. They viewed digital systems as necessary for improving primary care. However, they expected clearer procedures, stable infrastructure, stronger technical assistance, and better integration between local and national systems. Several participants suggested that training should be continuous, not limited to one-time socialization. Others emphasized the need for clear role division between clinical staff, record officers, program managers, and information system operators. One head of Puskesmas stated, “Digital systems will work better if every unit understands its role and if the applications are connected.” This finding shows that optimization requires more than individual competence. It requires institutional rules, resource support, system interoperability, and continuous evaluation.

Overall, the results indicate that digital health information systems in primary health care are perceived as useful, but their optimization remains constrained by fragmented applications, uneven user capacity, repeated reporting, infrastructure limitations, and weak integration. The participants' experiences show that digital transformation is not a linear process. It involves negotiation between policy demands, service routines, technical capacity, and local organizational culture. The meaning of "strengthening" digital systems in this context is not limited to adding new platforms. It means improving how people, systems, data, and work processes connect to support better primary health care.

Discussion

The findings confirm that digital health information systems should be understood through a sociotechnical perspective. Technology does not operate independently from users, workflows, institutional rules, and service culture. The presence of e-Puskesmas, electronic medical records, and SATUSEHAT integration can create opportunities for better data management, but these opportunities depend on the readiness of health workers and organizations. This aligns with Willis et al. (2022), who found that digital health interventions can strengthen prevention and primary care services when they are integrated into routine practice. The finding also supports Silva et al. (2022), who argued that digital health can improve coordination and service quality when technology responds to the real needs of providers and patients.

The issue of fragmented workflows is consistent with previous research on digital health implementation in primary care. Van Tilburg et al. (2024) reported that organizational context, professional acceptance, system usability, and implementation processes influence the success of digital health services. In this study, fragmentation appeared through double data entry, separate reporting platforms, and repeated verification. This finding shows that digitalization can create additional workload when systems are not interoperable. It also strengthens the argument of Erku et al. (2023), who noted that digital health interventions in primary care need stronger integration to improve access and quality. The contribution of this study lies in its emphasis on the daily experience of health workers who must translate digital policy into practical service routines.

The finding on uneven digital literacy supports the view that human resource capacity is a central factor in digital transformation. Sieck et al. (2020) found that adaptation to electronic health records requires training, technical assistance, and organizational support. In the present study, staff competence varied across roles and service units. Some users could operate systems for routine tasks but lacked confidence when facing technical errors or data inconsistencies. This finding shows that digital literacy should not be treated as a one-time training outcome. It must be developed as continuous professional learning. Scandiffio et al. (2024) also emphasized the role of mentoring and coaching in supporting digital technology adoption among health professionals. This study supports that conclusion by showing that informal peer support at the Puskesmas level can become a practical mechanism for strengthening digital capacity.

The finding on data quality adds an important perspective to the discussion of digital health systems. Many digital transformation programs focus on system availability, but this study shows that data quality depends on shared responsibility across units. Incomplete data, delayed entry, and inconsistent coding reduce the value of digital systems for decision-making. This finding aligns with de Siqueira Silva et al. (2024), who argued that digital health quality in primary care requires evaluation of service processes, information use, and organizational capacity. It also supports Aisyah et al. (2024), who found that ICT maturity in Indonesian health services remains uneven across human resources, software, hardware, and infrastructure. The present study extends these findings by showing that maturity is also reflected in daily data culture. A facility may have a digital system, but the system will not support primary care optimization if data are not trusted, complete, and usable.

Leadership and organizational support emerged as key factors in digital strengthening. This finding is consistent with the Consolidated Framework for Implementation Research, which identifies inner setting, implementation climate, readiness, and process as important domains of change (Damschroder et al., 2022). In this study, leadership support influenced role clarity, staff motivation, training opportunities, and problem-solving practices. However, leadership was not only formal. Peer mentoring and daily assistance among staff also shaped system adoption. This finding offers a more contextual understanding of digital implementation in Puskesmas. In resource-limited settings, informal learning networks may compensate for limited formal training. This does not mean formal training is unnecessary. Rather, formal training should be combined with workplace-based mentoring, helpdesk support, and routine evaluation.

The study also shows that digital health strengthening requires stronger governance. Participants expected clearer procedures, better interoperability, continuous training, reliable infrastructure, and technical assistance. This supports Fava and Lapão (2024), who emphasized that digital primary health care needs policy alignment, provider readiness, and patient-centered design. It also aligns with Yi et al. (2024), who noted that digital health innovations in South and Southeast Asia face challenges related to infrastructure, sustainability, digital literacy, and contextual adaptation. The findings suggest that digital governance at the primary care level should include four components: clear division of data roles, integrated reporting systems, continuous capacity building, and routine monitoring of data quality. These components can reduce double work and help digital systems become part of clinical and managerial decision-making.

Theoretically, this study contributes to digital health implementation literature by showing that optimization of primary health care requires alignment between technological systems and social practices. The sociotechnical perspective helps explain why the same technology can produce different outcomes across facilities. Implementation success depends not only on system features, but also on how users interpret the system, how leaders organize work, how data responsibilities are distributed, and how local culture supports change. The study also strengthens the relevance of CFIR in primary care digitalization because the findings reflect multiple implementation domains, including intervention characteristics, inner setting, outer setting, individual characteristics, and implementation process.

Practically, the findings suggest that Puskesmas and local health offices need to prioritize integration before adding new applications. Digital transformation should reduce workload, not multiply administrative tasks. Primary care facilities need continuous training programs, simple technical support channels, clear standard operating procedures, and internal data quality audits. Health workers also need protected time to learn and adapt to digital systems. Local health offices should support interoperability between local systems and national platforms, especially SATUSEHAT, while ensuring that reporting requirements remain realistic for frontline staff. These strategies can help digital health information systems support service quality, patient continuity, and evidence-based planning.

This study also has implications for future research. Further studies can compare digital system strengthening across urban, rural, and remote Puskesmas to identify differences in infrastructure, staffing, and organizational readiness. Future research may also examine patient perspectives on digital primary care, especially regarding access, privacy, satisfaction, and trust. Mixed-method studies can be conducted to connect qualitative experiences with measurable indicators such as service waiting time, data completeness, referral accuracy, and reporting timeliness. Longitudinal research is also needed to understand how digital health information systems evolve after SATUSEHAT integration becomes more established in routine primary care.

In summary, the results and discussion show that strengthening digital health information systems requires more than technological implementation. It requires integrated workflows,

skilled users, reliable data, supportive leadership, and clear governance. The study offers a contextual perspective on primary care digitalization by placing the voices of health workers and local managers at the center of analysis. This perspective is important because primary health care optimization depends not only on digital infrastructure, but also on how people use, trust, and sustain digital systems in everyday service practice.

4. Conclusions

This study concludes that strengthening digital health information systems is a key requirement for optimizing primary health care. The findings show that digital transformation at the Puskesmas level does not depend only on the availability of applications, electronic medical records, or national integration platforms. It also depends on integrated workflows, digital literacy, data quality, leadership support, peer learning, and clear governance. The main challenges found in this study include fragmented applications, double data entry, uneven user capacity, inconsistent data quality, and limited technical support. These findings confirm that digital health information systems should be understood as sociotechnical systems where technology, users, service routines, organizational culture, and policy structures interact in daily practice.

Theoretically, this study contributes to digital health implementation literature by showing that primary care digitalization requires alignment between system design and local work practices. Practically, the findings suggest that Puskesmas and local health offices need to strengthen interoperability, provide continuous training, establish clear data roles, improve technical assistance, and conduct routine data quality monitoring. From a policy perspective, digital health strengthening should prioritize integration and usability rather than the addition of new reporting platforms. Future research can expand this study by comparing urban, rural, and remote primary health care facilities, examining patient perspectives, or using mixed methods to connect qualitative experiences with service performance indicators.

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