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Enhancing Digital Health Literacy to Support Post-Pandemic Health Recovery in Indonesia: A Case Study in Makassar

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Assessing Digital Health Literacy in Indonesia: A Case Study in Makassar

Full research paper

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Abstract

The COVID-19 pandemic has highlighted the importance of information systems to support healthcare planning, management and delivery. Developing countries generally lag in digital transformation, particularly from the perspective of the readiness of human resources to engage with and deliver digital health services. This study examines the digital literacy level of health workers in Indonesia as an example of a developing country to identify areas for improvement. We proposed a digital health literacy framework based on a synthesis of existing indicators. Through a case study in Makassar, we reveal that healthcare workers are particularly lacking in digital health data acquisition and management as well as digital health data exchange and analysis. There is also a significant difference between management expectations and the actual healthcare workers' digital literacy levels. This study offers implications to research and practice on enhancing healthcare quality in developing countries

Keywords: healthcare, digital literacy, health information systems, case study, developing country

1 Introduction

The COVID-19 pandemic necessitated major changes to health systems especially in the use of information and communication technologies (de Morais Barroca Filho et al. 2021). Digitalization of the healthcare sector has been recognized as an initiative to mitigate risk in any country against a COVID-like situation in the future and address the United Nations Sustainable Development Goal of enhancing health and wellbeing for all (World Health Organization 2020). Many countries have quickly implemented various application systems such as COVID-19 Reporting and Data Systems (Turcato et al. 2021), risk of transmission assessment mobile applications (Pan 2020), Self-Screening Applications to control the spread of COVID-19 virus (Intawong et al. 2021), Laboratory Information Systems (Weemaes et al. 2020) and Web-based Intensive Care Unit (ICU) Bed Management systems (de Morais Barroca Filho et al. 2021). These diverse applications enable informed decision-making regarding healthcare service and resource allocation to support effective and efficient COVID-19 response management (Mbunge 2020).

However, unlike developed countries that have generally introduced various health information systems (HIS) to enhance healthcare management and delivery in the last decade, developing countries typically lag in the use of technologies within the healthcare sector (Cohen et al. 2015; Lucas 2008). Specifically, prior to the pandemic, the use of health information systems in developing countries was very ad-hoc, precluding the ability to effectively achieve data connectivity and data quality at the required levels (Piette et al. 2012). As a result, the health systems were struggling to cope with unprecedented challenges related to COVID-19 disease surveillance and provision of various essential health services to support the citizens (Kurnia et al. 2022)

The situation is further impaired by the lack of readiness of health workers in developing countries to deploy HIS and related technologies in providing healthcare services to the citizens (Ramadani et al. 2023). Previous research indicates that successful implementation of such systems is contingent upon the willingness and ability of the local actors/users to accept and deploy the systems effectively (Lederman et al. 2015; Ramadani et al. 2023). While there have been an increasing number of studies assessing digital health literacy in general, there is still limited research focused on the assessment of levels of digital literacy among health workers in developing countries (Liu et al. 2022; Mitchell and Kan 2019). Hence, it is difficult for the government in those countries to devise appropriate strategies and effective training programs to enhance the digital literacy of health workers and to increase the likelihood of success in HIS deployment at district/regional level.

To address the current knowledge gap, this study aims to assess the digital literacy level of health workers in Indonesia as an example of a developing country and to identify areas for improvement. We selected Makassar, the capital of South Sulawesi in Indonesia, as the study context. Makassar has only seen development in recent years and is representative of developing countries. In 2019, the economic growth in South Sulawesi reached 6.9 percent, which was greater than the five percent national growth rate (Evans and Millott 2020). During the COVID-19 pandemic, South Sulawesi was also severely impacted by serial waves of the pandemic in many sectors, including health sectors. The situation has had significant negative impacts on economic growth in the region, which ultimately will affect national economic growth. Furthermore, we focus on Makassar because of this rapid development where health workers' digital literacy levels are expected to be higher than other regions.

The research questions addressed are as follows: 1) *What is the current digital literacy level of health workers in Makassar,* 2) *What is the expected health workers' digital literacy level as perceived by the management,* and 3) *what is the digital skills gap that need to be addressed?* To address the research questions, we conducted a revelatory case study employing a combination of focus groups with healthcare management, as well as interviews and a survey of healthcare workers. First, we identify the current level of digital literacy of health workers in Makassar through a survey. Then, through a focus group, we explored hospitals and primary health centre's management expectations of the digital literacy level of health workers to enable them to effectively and efficiently use health information systems in managing and delivering health services. Finally, we conduct a skills-gap analysis to identify areas and strategies for enhancing the digital literacy levels of health workers in Makassar.

In the next section, we review previous related studies and existing frameworks used to assess the digital literacy of healthcare workers. Based on the common elements, we propose a framework to guide the assessment of the digital literacy of health workers. Then we explain our research approach, and present and discuss the case study findings. Finally, we conclude the paper by outlining study limitations and future research.

2 Literature Review

Digital transformation involves deployment of technologies to significantly transform business processes and models, which requires effective change management and new skills to adapt to major changes (Kozanoglu and Abedin 2020; Murawski and Bick 2017). Furthermore, organizational studies have highlighted that the digital literacy level of organisation's members is correlated with resistance to digital transformation, particularly in resisting a new way of working with technologies (Murawski and Bick 2017). Indeed, the healthcare sector views digital literacy as the expected capabilities of graduates and healthcare professionals (Brunner et al. 2018; Jimenez et al. 2020). Therefore, the digital literacy level of healthcare workers is one of critical determinants of holistic HIS usage and benefits achievement.

In the health sector, there have been a wide range of digital technology solutions and applications that have been developed to enhance healthcare service and delivery (World Health Organisation 2019). Many developing countries have increasingly adopted Telemedicine/Telehealth, Mobile Health applications, Electronic Health Records, Health Information Systems and other digital health applications (Labrique et al., 2013; World Health Organisation 2019). However, since the digital health landscape in developing countries is generally still evolving, the implementation of digital health applications arguably complex to manage. There are challenges to overcome including unreliable IT infrastructure, limited access to technologies, lack of resources to manage technology implementation and impact, lack of policies and regulations governing the use and exchange of digital health data and lack of skills and competencies (Mars and Scott 2019; Labrique et al., 2018a). In fact, effective deployment of such applications is necessary to promote digital transformation, which can potentially address the United Nations Sustainable Development Goal of enhancing health and wellbeing for all.

Our review of recent previous studies related to digital health literacy assessment indicates that studies on digital health literacy vary in terms of their focus. For example, one study investigates the predictors of digital health literacy level (Liu et al. 2022), whereas other studies measure digital health literacy and link various aspects. They investigate the impact of digital health literacy level on the use of national health records or digital health services (Cheng et al. 2022; Holt et al. 2019), the level of anxiety during the pandemic (Frings et al. 2022), information-seeking behaviour (Dadaczynski et al. 2021; Rosário et al. 2020), vaccination rate (Patil et al. 2021), integration of digital technologies (Kemp et al. 2021), ability to assess the accuracy of online health information (Liu et al. 2020), and quality of healthcare services (Smith and Magnani 2019). These studies offer a detailed understanding of the impact of digital health literacy on specific aspects of interest.

Importantly, our literature analysis has identified several research gaps. First, we only identified two studies conducted in the context of developing countries (Alipour and Payandeh 2022; Liu et al. 2022). This is a critical research gap since the adoption of digital technologies within the health sector in developing countries can improve health quality and access to health services to support Sustainable Development Goal of enhancing health and well-being for all (Labrique et al. 2018). The findings of related studies involving developed countries as the study context are unlikely to be applicable to developing countries due to the notable contextual differences (Mitchell and Kan 2019).

The second important research gap identified is that scant attention has been given to digital health literacy of specific occupations, such as healthcare workers, as most studies focused on the overall adult population (Cheng et al. 2022; Liu et al. 2022) or university students (Dadaczynski et al. 2021; Frings et al. 2022; Patil et al. 2021). This gap should be addressed as healthcare workers are at the frontline in integrating technologies into healthcare services (Mitchell and Kan 2019). Without an understanding of the digital health literacy of health workers, it is unlikely that technologies could be designed and deployed effectively to enhance the quality and delivery of healthcare services to the citizens. Moreover, it would deter the identification of health digital literacy improvement opportunities and the development of appropriate training programs.

Third, previous studies lack holistic assessment of digital health literacy. They mostly use eHealth Literacy Scale (eHEALS) (Kemp et al. 2021; Liu et al. 2020), Digital Health Literacy Instrument (DHILI) (Alipour and Payandeh 2022; Rosário et al. 2020), or Digital Health Literacy Questionnaire (eHLQ) (Cheng et al. 2022; Holt et al. 2019), each with its own strengths and limitations. Finally, our literature review has revealed that most previous research has been dominated by quantitative studies (Alipour and Payandeh 2022; Frings et al. 2022; Liu et al. 2022), while only two studies employ interviews and focus group (Cheng et al. 2022; Kemp et al. 2021). Deploying quantitative and qualitative research approaches will enrich the study findings in depth and generalizability (Morgan 2013).

Therefore, in addressing the above research gaps, our study involves development of a holistic digital health literacy framework to measure the digital health literacy level of healthcare workers in Indonesia as an example of a developing country, using a combination of quantitative and qualitative approaches. Next section presents the proposed digital health literacy framework, developed based on the synthesis of measures used in previous frameworks.

3 The Proposed Digital Literacy Framework

Numerous studies have provided frameworks to assess the digital literacy level of the stakeholders in the healthcare sector (Faux-Nightingale et al. 2022). Several well-known frameworks include the eHealth Literacy Scale (eHEALS), eHealth Literacy Questionnaire (eHLQ), the Digital Health Literacy Instrument (DHLLI), and eHealth Capabilities Framework for Graduates and Health Professionals (Faux-Nightingale et al. 2022). Each of these frameworks proposes a set of items that represent indicators of digital literacy with its own merits and limitations. By synthesising these existing frameworks, we propose a comprehensive measurement of digital health literacy. We systematically analysed the uniqueness and commonalities of each framework and then consolidated different indicators of healthcare digital literacy covered across those four eHealth literacy frameworks into our proposed framework. In addition, we conducted a broader review of the digital literacy-related literature to ensure that our framework covers all digital health competencies expected of healthcare workers. Our holistic digital health literacy framework primarily consists of six digital health literacy elements with 19 indicators. This framework is used in this study to measure current and expected digital literacy skills of healthcare workers in Makassar. The indicators for each element are tabulated in Table 1.

Healthcare Workers Digital Literacy Elements	Indicators	References
1. Foundational digital capabilities	1.1. Use of mobile devices. 1.2. Use of computing devices 1.3. Internet use 1.4. Ability to use electronic communication channels 1.5. Ability to use Microsoft suite 1.6. Ability to use of social media 1.7. Ability to search and assess the accuracy of online health information	(Kayser et al. 2018; Kuek and Hakkennes 2020; Norman and Skinner 2006; Van Der Vaart and Drossaert 2017)
2. Digital administration	2.1. Ability to use digital technologies related to billing. 2.2. Ability to use digital technologies related to appointments and reminders.	(Bartholomew 2011; Bulik and Shokar 2010; Hall 1996)
3. Digital clinical care	3.1. Ability to use technologies that support patient care (e.g., pathology or X-ray software) 3.2. Ability to use technologies to provide telehealth service 3.3. Ability to use technologies to provide health education materials	(Bartholomew 2011; Liaw and Marty 2001; Liaw et al. 2000)
4. Digital health data acquisition and management	4.1. Ability to store digital health data (e.g., electronic medical) according to record keeping standards. 4.2. Ability to maintain databases of digital health data.	(Cartwright et al. 2017; Liaw et al. 2000; Milano et al. 2014)
5. Digital health data exchange and analysis	5.1. Ability to retrieve and interpret digital health data (e.g., electronic medical record). 5.2. Understanding of the digital health referral systems. 5.3. Ability to perform basic data analysis such as data tabulation and charting of digital health data (e.g., frequency of disease).	(Bulik and Shokar 2010; Hall 1996; Liaw et al. 2000)
6. Ethics, and privacy protection and security of digital health data	6.1. Awareness of regulations related to the ethical use of digital health data. 6.2. Awareness of regulations related to privacy protection and security of health data.	(Bartholomew 2011; Bulik and Shokar 2010)

Table 1. The Proposed Health worker Digital Literacy Framework

4 Research Methodology

This study involves an in-depth investigation of digital literacy of health workers in Makassar, South Sulawesi. A case study is an appropriate method since it allows the researchers to access the study context, interact with the participants and obtain rich contextual information about the phenomenon (Yin 2018). A single, revelatory case study design was selected since the research team had a unique opportunity to investigate the phenomenon commissioned by Indonesian and Australian government funded institutions. These institutions assisted the establishment of the research team and access to research participants from the health office, communication and information office, social security agency, hospitals, and primary health care in Makassar.

We employed a mixed-method approach involving focus group, interviews and a survey. The focus group was conducted to obtain a high-level understanding of various health information systems in use and the management's expectation of digital literacy level of health workers to use the systems effectively. It was conducted in October 2022 involving 12 managerial level employees from the health office, communication and information office, social security agency, hospital, and primary health care in Makassar. Before we administered an online survey, we conducted in-depth interviews with four health workers from different health facilities, including hospitals and primary health centres. Appendix 1 provides two tables (Table A1 and Table A2) listing the focus group and interview participants, respectively. These participants represent key stakeholders in healthcare sector in Makassar. Further, the authority level of each participant, ranging from a high managerial position to a low level position, enabled us to reveal a holistic perspective in answering the research question posed in this study.

The interviews were conducted in early November 2022. The main purpose was to investigate the relevance of the digital literacy indicators captured in our proposed framework that were the basis of the survey questionnaire items. Besides serving as a pilot test before launching the survey, the interviews helped establish an initial understanding of digital literacy level of health workers in Makassar. Based on purposive sampling and using personal connections, four interview participants were selected and approached. Each interviewee represents a key stakeholder group.

Finally, an online survey was distributed in mid-November 2022 to assess digital literacy levels of health workers across the health facilities in Makassar. In total, we received 100 valid responses from health workers in both hospitals and primary health centres.

Content analysis of the focus group and interview data was conducted involving five steps (Tolley et al. 2016). Step 1 includes reading of the raw data, noting and identifying patterns. Step 2 involves identifying emerging concepts from the data. Three team members performed the data analysis and discussed their data coding to ensure consistency and reliability. Step 3 includes examining the data for finer distinctions within and among the themes, using data display memos and notes to track discoveries and begin to identify relationships between themes. Step 4 involves reducing the large dataset we collected to a manageable size to arrive at central themes. Finally, Step 5 includes interpretation of key themes and ensuring trustworthiness (Tolley et al. 2016).

The survey was conducted online using an instrument developed to obtain information about the digital literacy level of health workers. Responses to questions in the instrument are expressed in a Likert scale with a range of 1 to 5, where 1 indicates very low proficiency and 5 indicates very high proficiency. The survey assessed the health worker's level of digital literacy by considering: 1) demographics of health workers; and 2) level of digital literacy health workers. We calculated the mean value of each parameter based on the survey result to identify the digital literacy level of healthcare workers-

5 The Case Study

5.1 Case Study Background

Makassar is the capital of South Sulawesi and is the most populous city in this province. Approximately 15 percent of the population of South Sulawesi resides in Makassar. In addition, Makassar is the economic centre of South Sulawesi and, hence, there are many migrants coming from other regions, which further increase the population (Badan Pusat Statistik 2020). The population of Makassar in 2022 is 1,432,189 with 713,362 male residents and 718,827 female residents, spreading across 15 districts (Badan Pusat Statistik 2020). Various ethnic groups exist include Makassar, Bugis, Toraja, Mandar, Buton, Javanese, and Chinese. This city is classified as one of the largest cities in Indonesia in terms of its development.

Almost all levels of health facilities in Makassar have implemented several health information systems, especially for administration. However, the use of clinical HIS is still very minimal. Table 2 depicts various applications used in hospitals and primary health centres. It shows that application systems for resource planning and procurement are used in hospitals and PHCs to support administrative activities. Hospitals use only one application for resource planning and procurement, while Puskesmas deploys two applications. The procurement systems support activities related to resource planning such as financial management, planning activities and programs, procurement of goods and services/assets, as well as procurement of infrastructure and medical devices.

We also identified the use of application systems for human resources planning. However, in Makassar hospitals and primary health centers, only one system is used to manage health human resources and employee attendance. Furthermore, application systems for customer service are implemented to support online registration, doctor meeting services, and payments.

Currently, the electronic medical record system is only used by hospitals, as revealed below:

“By 2023, it is mandatory for hospitals to have electronic medical records system implemented. Currently in our hospital, all outpatients have electronic medical records” (Hospital Health Worker – Interviewee 3)

“Medical records, diagnostics, and treatment are still manual at the Primary Health Center” (Health Worker at Primary Health Centre – Interviewee 1)

However, other areas of patients’ records such as patient diagnostic records and patient drug records have not been implemented by hospitals in Makassar. Overall, the interviews revealed that HIS usage in the clinical field by hospitals is still lacking:

“Yes, mostly paper-based form. We haven't been able to implement PACS (Picture Archiving and Communication System). So, the results are still in paper form, requiring X-ray results to be taken to the doctor” (Hospital Health Worker – Interviewee 4).

Function	Application	Hospital	Primary Health Center (PHC)
Digital system for resources planning and procurement	• Procurement of goods and services/assets (SIMBAKDA)	√	√
	• Procurement of infrastructure and medical devices (ASPAK)		√
Digital system for staff planning	• Health Human Resource information system data (FASYANKES)		
	• Human Resources Needs Planning (HFIS BPJS)	√	√
Digital system for customer services	• BPJS Registration Through WA (PANDAWA)		
	• Online Registration or Queuing Registration (Antrian Online)	√	√
	• Phased Payment System from BPJS (REHAB)	√	
Digital system for managing patients medical record	• Electronic medical record	√	

Table 2. Examples of Administration and Clinical Health Information Systems Identified

5.2 Case Study Findings

5.2.1 The Current Digital Literacy level of Healthcare Workers in Makassar

The current digital literacy level of healthcare workers was identified through an online survey. In total, we received 100 valid responses. Around 61% of the respondents are medical workers (physicians and nurses), whereas 22% and 12% of respondents are health administrators and managers, respectively.

We also observe 15 respondents (5%) reported multiple responsibilities among medical, administrative, and managerial duties. In terms of education, the majority of our respondents (47%) hold a bachelor's degree, followed by a group of respondents (28%) holding a three-year diploma. Most of the respondents have worked for less than 3 years (32%), indicating that most healthcare workers are young professionals who are new to the workforce.

Table 3 shows that based on the survey data analysis, healthcare workers in Makassar perceived a below-average level of digital literacy. On a scale of 1 to 5, all indicators of digital literacy level were lower than 2.5. Among those indicators, foundational digital capabilities scored highest (2.41). Among seven sub-indicators in this capability, the score reflects that healthcare workers in Makassar are using electronic communication channels (2.5) and the Internet (2.48). They are also comfortable using mobile devices (2.42) and computing devices (2.42). However, they have low capability in using the Microsoft suites program (2.33) and verifying the accuracy of online health information (2.32). Following foundational digital capabilities, the second highest score was for understanding the ethics, privacy protection, and security of digital data (2.33). Finally, healthcare workers in Makassar lag in digital data acquisition and management (2.17) and digital data exchange and analysis (2.12).

Items	Score
1. Foundational digital capabilities	2.41
1.1. Use of mobile devices	2.42
1.2. Use of computing devices	2.41
1.3. Use of the Internet	2.48
1.4. Use of electronic communication channels	2.50
1.5. Use of Microsoft suites	2.33
1.6. Use of social media	2.40
1.7. Search and assess the accuracy of online health information	2.32
2. Digital Administration	2.21
2.1. Use of billing-related technologies	2.23
2.2. Use of appointment-related technologies	2.21
3. Digital Clinical Care	2.26
3.1. Use of patient-care related technologies	2.25
3.2. Use of telehealth-related technologies	2.29
3.3. Use of technologies to provide health education materials	2.27
4. Digital Health Data Acquisition and Management	2.17
4.1. Store digital health data	2.15
4.2. Maintain databases of digital health data	2.18
5. Digital Health Data Exchange and Analysis	2.12
5.1. Retrieve digital health data	2.10
5.2. Understanding of the digital health referral systems	2.15
5.3. Data analysis such as data tabulation and charting	2.09
6. Ethics, and privacy protection and security of digital health data	2.33
6.1. Awareness of ethical use of digital health data	2.21
6.2. Awareness of privacy protection and security of health data	2.44

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Table 3. Digital literacy level in Makassar

5.2.2 Management Expectation of Health Care Workers' Digital Literacy Level

In general, the results from the FDG indicate that the healthcare management expects the literacy of health workers in Makassar to be high. On a scale of 1 to 5 (1 being very low proficiency and 5 being very high proficiency), they scored five to most of the digital literacy elements. Selected quotes from the focus group participants are included in Table 4.

Below we summarize the key insights/themes obtained from the focus group with the management stakeholders.

- *High level digital literacy is expected for foundational capabilities, and ethics, privacy protection and security.*

As indicated in Table 4, the focus group participants believe foundational capabilities and awareness of ethics, privacy protection and security of digital health data among health workers should be very high. The view of the focus group participants is further captured below:

“If they have not reached the level of five, they have to be trained. Everyone must be digitally capable. No excuses. Everyone must be trained to be capable... In terms of the awareness of the ethics, privacy and security of digital health, it must be level 5. No way to share any information about patients’ records. We really protect patients’ sensitive information”. (Informant 3 - District Health Office Makassar)

Digital Literacy Element	Expected Proficiency Level	Selected Excerpt from the Focus Group
Basic Digital Capabilities	5	<i>“Because of pandemic, everyone seems to have increased their basic digital capabilities ...”</i> (Informant 5, District Health Office Makassar)
Administration	5	<i>“Good, but still need more training”</i> (Informant 12 – Makassar General Hospital)
Clinical Care	5	<i>“Probably 5... sometimes there are still obstacles”</i>
Digital Data Acquisition and Management	5	<i>“5 ... even though confidence level is probably lacking. Because they always feel they can't.</i> (Informant 7 - Primary Health Center Tamamaung)
Digital Data Exchange and Analysis	4	<i>“4 maybe, in terms of analyzing, that's where the function is still lacking, that's key to the manager.”</i> (Informant 9, Primary Health Center Kassi-Kassi)
Ethics, Privacy, and Security	5	<i>“That's 5. Certainly. Maintaining privacy is very important”</i> (Informant 1 - Wahidin Sudirohusodo Hospital)

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Table 4. Management Expectation of Digital Literacy of Health Workers in Makassar

- *Digital literacy level for administration and clinical care is expected to be very high but still needs improvement.*

Based on the focus group and interviews, the management believe the capabilities to use administrative and digital clinical care applications still need strengthening and training. However, there is a clear expectation that health workers must be very proficient in both digital administration and clinical care, as revealed below:

“In terms of clinical care, there is a clear expectation that we want them to reach level 5. However, the reality is perhaps only level 4. Some of them are still struggling with the input data required. Hopefully, as they gain more experience, the proficiency level can be increased”. (Informant 12 - Makassar General Hospital)

“For digital administration, it must be five. There should be no mistakes since this is about healthcare service. The accreditation team will conduct an internal audit to ensure that there is no mistake”. (Informant 4 - District Health Office Makassar)

- *Digital literacy levels for data acquisition and management and for data exchange and analysis are still lacking.*

The management also acknowledges the importance for healthcare workers to have high capabilities in digital data acquisition and management, as well as digital data exchange and analysis, as demonstrated below:

“In general, everyone is capable of using digital technologies, but not for analysing and reporting purposes”. (Informant 12 - Makassar General Hospital)

“If the scale is 1 to 5, we expect at least 4 because I said earlier... they must be able to prepare data in a processed form, already useful information” (Interviewee 3 - Health Worker at Hospital)

- *The management has a lower expectation of digital literacy level of senior health workers.*

Our study indicates that the management expectation of health workers’ digital literacy level is influenced by the age of health workers. The management acknowledged the challenges facing senior health workers in using digital health applications since they were used to dealing with paper-based systems. Hence, the management lowered their expectation, as noted below:

“... the human resources in the puskesmas [Primary Health Centers], if they were born in 1970 and below, then it seems to be a little difficult to expect them to be literate about technology”. (Informant 4 - District Health Office Makassar)

“Everyone must be able to reach level 5. For the seniors, we can compromise. But for the young ones, no excuses. They can be trained until they have the expected capabilities. They must be digitally literate.” (Informant 3 - District Health Office Makassar)

5.2.3 Digital Literacy Skills Gap

We identified digital literacy skills gap by comparing the expected digital literacy level of the management that we obtained during focus group and interviews with the survey data indicating the current digital literacy level of health workers in Makassar. We found significant differences between the management expectation and healthcare workers’ perception of their digital literacy levels, as shown in Figure 1. Overall, contrary to the assessment of healthcare workers’ digital literacy level, the management expects that the health workers in Makassar should possess a high or very high level of digital literacy across the six digital literacy elements.

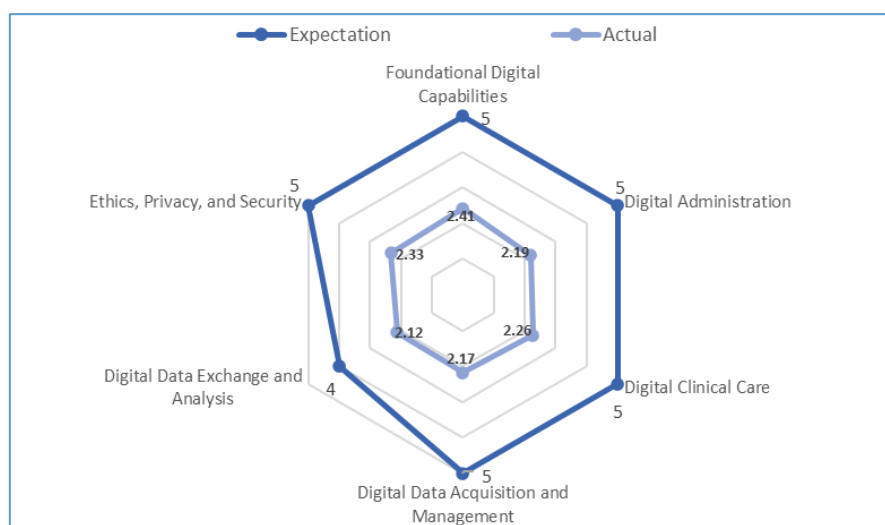


Figure 5. Expected and Actual Digital Literacy Level in Makassar

The significant gap between the expected and actual digital literacy level in Makassar could be related to insufficient training provided to health workers to enable them to develop the expected digital literacy capabilities. Therefore, health workers are generally not confident in their ability to use various government-provided applications. Furthermore, the trainers are often deemed not to be proficient enough, as noted by a health worker at a Primary Health Center:

“For example, those who conduct the training are also not too skillful. Often, they also need more training from the health office ... “It relates to the health department as well. How they facilitate learning for us. This is about the application anyway. They should provide training”. (Interviewee 2 - Health Worker at Primary Health Centre)

6 Discussion

In the last two years, the Indonesian government and various institutions including the private sector, industry, NGOs and academia have been collaborating closely to overcome existing challenges and improve health information systems and data management in Indonesia. Specifically, the Ministry of Health issued a digital transformation blueprint overseen by the newly created Digital Transformation Office. However, although the Ministry of Health has managed resources primarily at the national level, the main challenge in implementing health information systems occurs at the district/regional level as noted in previous studies (Lederman et al. 2015; Ramadani et al. 2023). Assessing the digital literacy of health workers to identify improvement opportunities is therefore important to empower health workers in deploying various technologies and systems effectively to deliver health services efficiently and improve healthcare provision and quality.

This study aims to assess the digital literacy of health workers in Indonesia and to identify areas for improvement Through an in-depth case study of Makassar, the capital of South Sulawesi in Indonesia,

we explored various health information systems that have been successfully implemented at different levels of healthcare provision and analysed the digital literacy level of healthcare workers. Further, we explored management expectations of digital literacy of health workers to enable them to use various health information systems effectively. Overall, our findings indicate that the implementation of health information systems in Makassar has been significantly improved. Healthcare facilities at different levels integrate digital technologies in customer-facing and back-end operations. However, we found that the digital literacy level of healthcare workers in Makassar is currently inadequate. Unlike the study by Alipour and Payandeh (2022) indicating healthcare workers in Iran have established a sufficient digital literacy level in operational, navigation, information searching and privacy protection, our study shows that digital literacy levels of healthcare workers in Makassar are still below average even for those basic/foundational digital capabilities, as well as competencies in ensuring ethical use of digital health data as, health data privacy and security. Such low levels of digital literacy can become an obstacle in materialising the benefit of health information systems since digital literacy level of health workers is a critical factor for successful digital transformation (Kozanoglu and Abedin 2020; Murawski and Bick 2017).

Our study findings further reveal a significant gap between the expected and actual digital literacy of health workers in Makassar. The focus group indicate that the management has a high expectation of health workers' digital literacy, while our survey reveals that the healthcare workers themselves are not confident with their current level of digital literacy in all aspects based on our framework. The highest capability possessed by the healthcare workers is foundational digital capabilities. This is followed by their understanding of digital privacy protection and security. The current lowest capability is in working with data, particularly in data acquisition, management, and analysis.

Enhancing the digital literacy level of healthcare workers could be achieved through several strategic initiatives involving multiple stakeholders. One possible avenue is developing comprehensive training programs covering the basics of data analysis and digital literacy, as well as advanced topics relevant to healthcare (e.g., health-related indicators for monitoring and evaluation of healthcare services). Healthcare key stakeholders, particularly from the Provincial Health Office and the Provincial Communication and Informatics Office, should coordinate the efforts and consider collaborating with local universities, technology companies, and other related organizations in developing and delivering such training programs. This collaboration helps ensure the training programs are relevant and up to date with the latest technological advances and the trainers are well qualified. Further, the training programs should be accessible and relevant to health workers in Makassar and other regions in South Sulawesi, considering specific challenges and needs for each region. The government and policy makers should also foster a culture that values data and digital literacy within healthcare institutions by creating opportunities for health workers to apply their new skills, as well as recognizing and rewarding health workers who demonstrate excellence in data and digital literacy. Finally, continuous assessment of digital literacy of health workers should be carried out to evaluate the effectiveness of the training programs and identify improvement opportunities.

This study offers several implications to research on digital literacy in the healthcare sector. First, this study proposes a new and comprehensive framework, covering six important elements with a total of 19 indicators. Our framework is developed by integrating eHEALS, eHLQ, DHLL, and eHealth Capabilities Framework for Graduates and Health Professionals into one holistic framework. Future studies can deploy our framework to conduct a holistic assessment of digital literacy of health workers in other contexts. Second, this study enhances the current understanding of digital literacy of health workers who play a key role in improving the quality of health care service and delivery through effective use of technologies. Digital literacy of healthcare workers has indeed been recognised as a critical factor for digital transformation in the healthcare sector (Lederman et al. 2015; Ramadani et al. 2023). Previous studies (e.g., Liu et al. (2022, Holt et al. (2019, Dadaczynski et al. (2021, Rosário et al. (2020, Kemp et al. (2021) only focus on the assessment of digital literacy level of citizens or students in developed countries. Thus, our study addresses an important research gap by providing an exemplar study that specifically focuses on healthcare workers in a developing country, which can guide the development of effective training programs to enhance their digital literacy. Finally, this study employs a case study method involving a combination of qualitative and quantitative approaches to data collection including interview, focus group, and survey. Such an approach allows for a detailed understanding of the digital literacy level of healthcare workers, the expected level, and the skills-gaps, which can be used to devise strategies and introduce appropriate initiatives involving multiple stakeholders to improve digital literacy level of health workers.

7 Conclusion

Given the potential and importance of digital transformation in the health sector and the slow uptake of health information systems in developing countries in general, this study was initiated to assess digital literacy level of health workers in Makassar and to identify areas for improvement. Although various health information systems have been implemented in healthcare facilities in Makassar, our study findings indicate that healthcare workers in Makassar are generally lacking in all aspects of digital literacy specifically in digital health data acquisition and management as well as digital health data exchange and analysis. There is also a significant difference between management expectation and the actual healthcare workers' digital literacy levels, inhibiting the ability to deploy health information systems and related health data effectively and efficiently. The management of healthcare facilities expect a high level of digital literacy in all aspects. However, healthcare workers perceived a lower level of digital literacy in all aspects. Our study thus highlights an urgent need for capacity building for health workers, which can be achieved through comprehensive training programs, collaboration with local universities, technology companies, and other related organizations to develop and deliver appropriate and effective training programs, as well as continuous assessment of healthcare workers' digital literacy. Our study enriches the literature on digital health literacy in developing countries which is currently limited and contributes to the global effort in enhancing digital health literacy by providing a comprehensive framework that has been successfully applied in this study to identify the skills gap and appropriate interventions that could reduce the gap.

This study has several limitations. First, we only conducted four interviews with health workers to verify the insights obtained from the focus group, to gain initial understanding of health workers' digital literacy and to assess the relevance of the questionnaire items. While the interviews were useful to pilot test the questionnaire items before launching the survey, the limited number of health workers interviewed did not provide sufficient details to corroborate the survey findings. Second, the large discrepancy between the management expectation and the actual digital literacy of healthcare workers could be attributable to the way questions were asked. During the focus group, when asking about the expected digital literacy level of health workers for those six digital literacy elements assessed, not all indicators of each element were discussed. Hence, the management might generalize and inflate their expectations of the digital literacy level of healthcare workers. For example, for the first digital literacy element, the management was asked "what is the current level of foundational digital capabilities of healthcare workers in your workplace?". This single-line question might reduce their understanding of specific aspects of foundational digital capabilities. By contrast, the survey questionnaire shows seven statements representing the multidimensionality of foundational digital capabilities. Nevertheless, during the focus group, we often provided further details as necessary. Hence, we believe that the insights obtained from the focus group have captured the overall management expectation, rendering our conclusion valid that the current digital literacy level of healthcare workers in Makassar still needs improvements in all six elements.

Future research could extend our research by conducting in-depth interviews with health workers in Makassar to better understand the main challenges and issues experienced in deploying various applications systems effectively to enhance the quality of healthcare administration and delivery. Furthermore, future research could consider conducting a longitudinal study to examine the effects of various future interventions introduced by the key stakeholders of the healthcare sector at the national and provincial levels to enhance digital literacy. Such a longitudinal study would offer an excellent opportunity to identify key enablers and challenges in development of effective interventions and how challenges could be mitigated overtime. Lessons learned would be valuable for Makassar as well as other regions in Indonesia and beyond to enable them to seize the golden opportunities from digital health transformation.

In addition, future studies replicating our study in other parts of Sulawesi and other main islands of Indonesia including Sumatra, Borneo and West Papua would enhance the generalizability of our study findings. Such studies should also consider the contextual factors that are distinct to each region/island and examine if they have impact on the digital literacy skills of health workers. Moreover, future comparative studies involving other developing countries would be useful to better understand key challenges and issues experienced by developing countries in undertaking digital health transformation. Such an understanding would assist in identifying appropriate coordinated international collaboration and response to overcoming the identified challenges and thus enhancing the quality of global health services.

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Appendix 1

Informants	Type of Institution	Role	Gender
Informant 1	Class A Teaching and Referral Hospital	Sub-coordinator for Research and Development	Female
Informant 2	Information and Communication Office	Head of the Communication and Information Office	Male
Informant 3	District Health Office Makassar	Planning Staff	Male
Informant 4	District Health Office Makassar	Family Health Staff	Female
Informant 5	District Health Office Makassar	Head of Disease Prevention and Management	Female
Informant 6	District Health Office Makassar	Head of Public Health	Female
Informant 7	Primary Health Center	Doctor	Female
Informant 8	District Health Office Makassar	Health Service Staff	Female
Informant 9	Primary Health Center	Nurse	Female
Informant 10	Social Security Agency of Health (BPJS Kesehatan) Makassar	Staff UPKRAF	Female
Informant 11	District Health Office Makassar	Head of Health Services	Male
Informant 12	Class B Government Hospital	Medical Record Staff	Female

Table A1. List of Focus Group Participants

Interviewee	Type of Institution	Role	Gender	Age
Interviewee 1	Primary Health Care	Doctor	Female	46
Interviewee 2	Primary Health Care	Nurse	Female	37
Interviewee 3	Class A Teaching and Referral Hospital	Sub-coordinator for Research and Development	Female	41
Interviewee 4	Class B Government Hospital	Medical Record Staff	Female	39

Table A2. List of Interviewees

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