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From system to people: Strengthening health professionals and systems readiness for dengue control

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Abstract

Dengue remains a significant public health challenge in Indonesia, making health workers and Health System Readiness key factors in ensuring effective case prevention and control. Gaps in organizational levels, facility resources, and individual capacity are often major barriers to rapid and comprehensive response efforts. This study aims to analyze the influence of individual, organizational, and structural factors on Health Profession-als' Readiness and Health System Readiness in the context of dengue control. The study population included health workers working in Primary Health Care facilities (PHCs) and general hospitals directly involved in den-gue hemorrhagic fever (DHF) prevention and control programs in Indonesia. A total of 201 respondents were selected as the sample using a purposive sampling technique. The analysis method uses the Partial Least Squares–Structural Equation Modeling (PLS-SEM) approach using software SMART-PLS version 4. The re-sults showed that Health Professional Readiness was primarily influenced by Organizational Factors, while Health System Readiness was predominantly determined by Hospital Resources. Individual factors such as knowledge and attitudes did not contribute significantly to readiness. Furthermore, the results of the Im-portance–Performance Map Analysis (IPMA) confirmed that health facility resources had the highest level of importance in improving system readiness. In conclusion, strengthening organizational structures and facility resource capacity is a key strategy to improve the readiness of health workers and the health system in dealing with and controlling dengue in Indonesia.

Keywords: Health worker readiness, Health system readiness, Dengue, Dengue Hemorrhagic Fever (DHF), Health facili-ties, Hospital resources, Organizational factors.

Introduction

Dengue Hemorrhagic Fever (DHF) remains a serious global health problem. More than 390 million infections occur annually, with 96 million cases showing clinical symptoms and 500,000 developing severe dengue requiring intensive care (Pang, Mak, & Gubler, 2017). This situation demands optimal preparedness, not only at the health system level, but especially among healthcare workers who are on the front lines of case detection, diagnosis, and management.

Sudan's experience demonstrates that the weak preparedness of healthcare workers in facing the 2019 dengue epidemic resulted in delayed diagnosis and increased mortality (Bagahizel & Elkhatim, 2023). A similar situation was observed in Tanzania, where limited clinical training, weak coordination, and limited laboratory facilities contributed to the healthcare workforce's ability to respond to the dengue epidemic (Mboera et al., 2021). Conversely, Pakistan successfully strengthened its response through the adaptation of its Incident Management System and Public Health Emergency Operations Center, which improved coordination and preparedness of medical personnel (Malik et al., 2021).

In addition to structural factors, Community Literacy also contributes. A study in Thailand showed that drama-based education improved community dengue literacy, resulting in patients arriving at health facilities more quickly, helping healthcare workers prevent severe cases (Padchasuwan et al., 2024). These findings confirm that healthcare worker readiness is influenced not only by Organizational Factors but also by knowledge, attitudes, and Top Management Support.

Globally, the literature emphasizes the need to strengthen healthcare worker-based readiness for dengue control, involving evidence-based policies, risk management, and multisectoral collaboration (Salehi et al., 2025). Therefore, this study will analyze the factors influencing Health Professionals' Readiness for dengue control using a PLS-SEM approach.

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The readiness of healthcare workers in controlling dengue fever is influenced by various internal and external factors, both at the individual and organizational levels. Organizational Factors such as the availability of infrastructure, policies, work culture, and managerial support have been shown to enhance healthcare workers' readiness to face the transformation of digital healthcare services (Kruszyńska-Fischbach et al., 2022). This readiness is even more crucial when dengue control is directed towards the use of integrated digital systems, which require technical competence, a positive attitude, and strong institutional support.

One key factor is Knowledge of Digital Dengue Control Systems (KNW), which is the level of healthcare workers' understanding of digital systems used for early detection, case reporting, and cross-sector coordination in dengue control. Wubante et al. (2022) showed that healthcare workers with adequate knowledge of digital systems are more prepared to manage cases, conduct early diagnoses, and implement prevention strategies. Strong knowledge is a key foundation for successful digital system implementation because it helps healthcare workers understand the benefits, procedures, and potential of technological innovations in infectious disease control.

In addition to knowledge, attitude toward the Digital Dengue Control System (ATT) is also a crucial factor in shaping healthcare worker readiness. A positive attitude toward technological innovation will increase healthcare worker engagement in the digitalization of dengue control programs (Wubante et al., 2022). When healthcare workers have a positive perception of digital systems, such as the belief that they facilitate reporting and improve the effectiveness of case monitoring, the level of technology adoption and individual readiness will increase. This attitude is also influenced by previous experience using health information systems or technology-based programs.

Furthermore, Top Management Support (TMS) plays a key role in strengthening healthcare worker readiness. Support from hospital and health office leaders in the form of providing resources, supervision, training, and strategic direction has proven to be a determining factor in the successful implementation of new systems (Ngusie et al., 2022). When top management demonstrates commitment to digital transformation, both through policies and incentives, healthcare workers' motivation to adapt to the digital dengue control system will increase. Strong management support also creates a sense of security for healthcare workers in the face of change.

From an organizational perspective, Organizational Factors (OF) such as policy structure, infrastructure availability, and a collaborative work culture are crucial for a healthcare institution's readiness. Kruszyńska-Fischbach et al. (2022) emphasized that e-health readiness is highly dependent on Organizational Factors that support change, including inter-unit coordination and effective communication mechanisms. Organizations with strong support systems will adapt more quickly to the use of the Digital Dengue Control System, resulting in more efficient and accurate case detection, reporting, and response processes.

Overall healthcare workforce readiness, or Healthcare Professionals' Readiness (HPR), reflects an individual's ability and willingness to adapt to digital systems in the context of dengue control. HPR encompasses cognitive (knowledge), affective (attitude), and structural (organizational support) aspects. Findings by Bagahizel and Elkhatim (2023) and Mboera et al. (2021) indicate that low healthcare workforce readiness contributes to delayed diagnosis, poor clinical management, and increased mortality from dengue outbreaks. Therefore, improving healthcare workforce capacity and readiness is a top priority in the epidemic response system.

At the system level, supporting variables such as Hospital Resources (HR), Managerial Readiness (MR), External Support (ES), and Community Literacy (CL) also contribute to Health Systems Readiness (HSR). The availability of adequate Hospital Resources, such as medical facilities, professional staff, and information technology systems, strengthens Health System Readiness (Rajapaksha & Wickramasinghe, 2021). Furthermore, strong Managerial Readiness, including leadership skills, internal policies, and inter-unit coordination, is a crucial factor in the successful implementation of digital systems (Yassen et al., 2023).

External Support from the government, donor agencies, and international partners also strengthens Health System Readiness, particularly in the provision of funding, technical assistance, and training of medical personnel (Alwan et al., 2023). Furthermore, Community Literacy (CL) plays a role in strengthening the success of technology-based dengue control. When the public has a good understanding of digital case reporting systems and prevention strategies, the public response to outbreaks becomes faster and more effective (Padchasuwan et al., 2024).

The combination of individual health worker readiness (HPR), organizational support (OF, TMS), and structural Health System Readiness (HR, MR, ES, CL, HSR) forms a comprehensive readiness model relevant for digital-based dengue control. Previous research has focused more on macro-level system readiness, such as organizational structure and hospital capacity (Bagahizel & Elkhatim, 2023; Mboera et al., 2021), while aspects of healthcare worker readiness at the individual level remain underexplored. Therefore, this study offers novelty by shifting the focus from a systems perspective to the individual level, integrating digital variables such as Knowledge and Attitude Toward Digital Dengue Control Systems as key determinants of healthcare worker readines.

The urgency of this research is heightened given the high global burden of dengue, with over 390 million cases annually (Pang et al., 2017). Weaknesses in healthcare worker readiness can lead to delayed diagnosis and a weak response to outbreaks (Mboera et al., 2021). Conversely, interventions involving training, managerial support, and the use of digital systems have been shown to increase the effectiveness of epidemic control (Malik et al., 2021; Salehi et al., 2025). Thus, a comprehensive understanding of the factors influencing the readiness of health workers towards digital dengue control systems is crucial as a basis for formulating policies and strategies to increase human resource capacity in the health sector.

The research objectives of this study are to answer the following research questions:

1. How do Organizational Factors Influence Health Professional Readiness in implementing dengue control programs? How does Health Professional Knowledge about the disease, diagnosis, and clinical management of dengue affect Health Professional Readiness?
2. How do Health Professional Attitudes toward innovation, training, and preventive involvement influence Health Professional Readiness? How does Top Management Support through policies, resource allocation, and supervision contribute to improving Health Professional Readiness?
3. How does Hospital Resources contribute to improving Health System Readiness? How does Managerial Readiness contribute to improving Health System Readiness?
4. How does External Support contribute to improving Health System Readiness?
5. How does Community Literacy contribute to improving Health System Readiness?

Method

Research Model Evaluation Methodology

This study uses a triangulation of analytical methods to evaluate the proposed research model on Health Professional Readiness in controlling dengue fever (DHF). The first step involved a comprehensive literature review related to e-health readiness and Organizational Factors within the health system. This review was used to establish the conceptual basis of the research model and formulate the hypotheses to be tested. This process focused on four main research questions structured around a hypothetical framework.

The second step involved collecting primary data using a random sampling survey of health professionals in primary health care (PHC) facilities in the study area. Respondents included doctors, nurses, midwives, and community health workers directly involved in dengue prevention and control activities. The third step was data analysis using Partial Least Squares–Structural Equation Modeling (PLS-SEM) to estimate the relationships between variables in the structural model and test hypotheses H1–H8. In applying PLS-SEM, this study followed the guidelines for the ratio of the number of respondents

to the number of indicators as recommended by Hair et al. (2021), namely an ideal ratio of 10:1, an adequate ratio of 5:1, and a minimum ratio of 3:1. Based on the data obtained, the ratios used in this study met the eligibility criteria for the applied empirical method.

Population and data collection: The population in this study consisted of healthcare workers working in primary health care (PHC) facilities and general hospitals directly involved in Dengue Fever (DHF) prevention and control programs in Indonesia. This population includes doctors, nurses, sanitarians, and community health workers who use digital devices or surveillance systems for vector monitoring and reporting of DHF cases.

The number of respondents in this study was 100–150 healthcare workers selected using a purposive random sampling technique, with the aim of obtaining representation from various types of facilities and regions with varying levels of DHF endemicity. This sample size was deemed adequate for exploratory analysis using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) method, with an estimated margin of error of less than 7 %. (Avkiran, 2018)

Data collection was conducted in October 2025 via an online questionnaire using Google Forms. Respondents were asked to indicate their level of agreement with each statement using a five-point Likert scale, with the following categories: 1 — Strongly Disagree, 2 — Disagree, 3 — Neutral, 4 — Agree, and 5 — Strongly Agree.

Before completing the questionnaire, each respondent was provided with an informed consent form explaining the purpose of the study, guaranteeing data confidentiality, and affirming that participation was voluntary. The data collection process was conducted ethically, ensuring that no personal information could identify respondents.

Table 1. Measurement

Variable	Code	Item
1. *Organizational Factors*	OF1	1. Implementing digital solutions is a critical part of the organization's dengue control strategy.
	OF2	2. Every employee understands the relationship between their duties and the success of the digital dengue control program.
	OF3	3. Leaders have the ability to implement digital health solutions.
	OF4	4. The organization provides digital training for healthcare workers at all levels.
	OF5	5. The organizational model encourages collaboration between medical, administrative, and IT personnel in the dengue program.
	OF6	6. Modern technology is used to accelerate the implementation of the dengue control program.
	OF7	7. Leadership support ensures the sustainability of the digitalization of healthcare services for dengue control.
2. *Health Professional Knowledge*	HPK1	1. I understand the clinical symptoms that indicate dengue infection.
	HPK2	2. I understand the appropriate diagnostic methods for detecting dengue cases.
	HPK3	3. I understand the principles of patient management for dengue.
	HPK4	4. I understand the procedures for reporting dengue cases to health authorities.
	HPK5	5. I understand the environmental risk factors associated with the spread of dengue.
	HPK6	6. I understand the national policy on dengue control in healthcare facilities.
	HPK7	7. I understand the use of information technology in the early detection of dengue cases.
3. *Health Professional Attitude*	HPA1	1. I have a positive attitude towards the use of digital innovation in dengue prevention.
	HPA2	2. I am interested in participating in training focused on improving dengue-related competencies.

	HPA3	3. I am passionate about participating in dengue control activities.
	HPA4	4. I consider changing work procedures to improve dengue prevention important.
	HPA5	5. I believe collaboration among healthcare workers improves the success of dengue control.
	HPA6	6. I feel personal responsibility is important in dengue prevention in the workplace.
	HPA7	7. I believe active involvement in patient education can strengthen the success of dengue programs.
4. *Top Management Support*	TMS1	1. Leadership supports dengue control policies in healthcare facilities.
	TMS2	2. Leadership provides the necessary resources for the implementation of the dengue program.
	TMS3	3. Leadership conducts oversight to ensure the effectiveness of the dengue program.
	TMS4	4. Leadership motivates healthcare workers in implementing dengue prevention innovations.
	TMS5	5. Leadership provides clear direction regarding dengue control strategies.
	TMS6	6. Leadership responds to facility needs related to the dengue program.
	TMS7	7. Leadership demonstrates commitment to improving healthcare worker preparedness in dealing with dengue cases.
5. *Hospital Resources*	HR1	1. The hospital has adequate medical equipment for dengue diagnosis.
	HR2	2. Healthcare workers receive training appropriate to their responsibilities in dengue management.
	HR3	3. The hospital has a clear communication system for coordinating dengue control.
	HR4	4. The work environment is safe for healthcare workers treating dengue patients.
	HR5	5. The hospital provides emotional support to healthcare workers when facing a surge in dengue cases.
	HR6	6. The hospital ensures the availability of personal protective equipment during dengue care.
	HR7	7. The hospital provides logistical resources to support the implementation of the dengue control program.
6. *Managerial Readiness*	MR1	1. The manager understands the organization's need to strengthen the readiness of the dengue control program.
	MR2	2. The manager has a strategy to overcome obstacles in implementing the dengue program.
	MR3	3. The manager ensures the availability of training for staff in implementing the dengue policy.
	MR4	4. The manager is adaptable to changes in the implementation of the dengue program.
	MR5	5. The manager assesses staff performance based on their involvement in dengue control.
	MR6	6. The manager provides resources to support the efficiency of health workers.
	MR7	7. The manager maintains a work environment conducive to the implementation of the dengue control program.
7. *External Support*	ES1	1. Our institution receives technical support from external agencies related to the dengue control program.
	ES2	2. International agencies assist in providing resources for the dengue program.
	ES3	3. The local government provides policy support for the implementation of the dengue program.
	ES4	4. Local communities play a role in supporting dengue prevention efforts.
	ES5	5. Our organization receives assistance from national health agencies regarding the implementation of the dengue program.
	ES6	6. The private sector contributes to the provision of facilities for dengue control.

	ES7	7. Collaboration with external partners improves the health system's preparedness for dengue outbreaks.
8. *Community Literacy*	CL1	1. The community understands the early symptoms of dengue infection.
	CL2	2. The community can identify simple preventive measures against dengue.
	CL3	3. The community understands the importance of seeking medical help at the first sign of symptoms.
	CL4	4. The community understands how to maintain environmental cleanliness to reduce the risk of dengue.
	CL5	5. The community can assess health information related to dengue prevention.
	CL6	6. The community understands the role of vaccination in reducing the impact of dengue disease.
	CL7	7. The community can actively participate in health education activities about dengue.
9. *Health Professional Readiness*	HPR1	1. I understand the standard procedures for implementing dengue control programs in health facilities.
	HPR2	2. I have sufficient knowledge about the symptoms and early treatment of dengue cases.
	HPR3	3. I feel I have sufficient skills to carry out interventions related to dengue control.
	HPR4	4. I am able to use the tools or technology used in detecting and reporting dengue cases.
	HPR5	5. I am highly motivated to participate in dengue control activities.
	HPR6	6. I feel my responsibility as a health worker is important in reducing the incidence of dengue.
	HPR7	7. I am ready to adapt to new procedural changes in the dengue control program.
10. *Health System Readiness*	HSR1	1. Our health facility has adequate resources to support the dengue control program.
	HSR2	2. Our health information system functions well in reporting and monitoring dengue cases.
	HSR3	3. Health facility leadership supports the implementation of the dengue control program.
	HSR4	4. There are clear internal policies regarding dengue management and prevention.
	HSR5	5. Coordination between units (laboratory, outpatient, inpatient) in handling dengue cases is effective.
	HSR6	6. We collaborate well with external parties (Health Office, community) in dengue prevention.
	HSR7	7. Our health system is ready to adapt to innovations or new policies in dengue control.

Research ethics: The questionnaire in this study was developed based on a review of relevant literature on Health Professionals' Readiness and Organizational Factors in controlling infectious diseases, specifically dengue fever (DHF). The survey instrument was then validated by a research team from the academic institution that sponsored the study, in consultation with the management of healthcare facilities in the study area, to ensure the context and language of the questions were appropriate to field practices.

Before data collection, all research procedures underwent an ethics review by the Health Research Ethics Committee at the relevant institution and were deemed to comply with research ethics principles, including respect for participants, data confidentiality, and voluntary participation. The survey was conducted anonymously without revealing the personal identities of respondents, including their names or the names of their institutions.

Each healthcare worker who participated in the survey was provided with a research information sheet explaining the purpose, benefits, and procedures of the study, including their right to refuse or withdraw at any time without any consequences. Informed consent was obtained through signing the consent form or through electronic confirmation from respondents who completed the online questionnaire.

During the data collection process, researchers ensured that all information provided by

respondents was confidential and used solely for academic purposes. Survey data was securely stored and inaccessible to parties outside the research team. Therefore, this research was conducted in accordance with applicable ethical standards for social and public health research in Indonesia and adhered to the general principles of the Declaration of Helsinki on the protection of human research subjects.

Result and Discussion

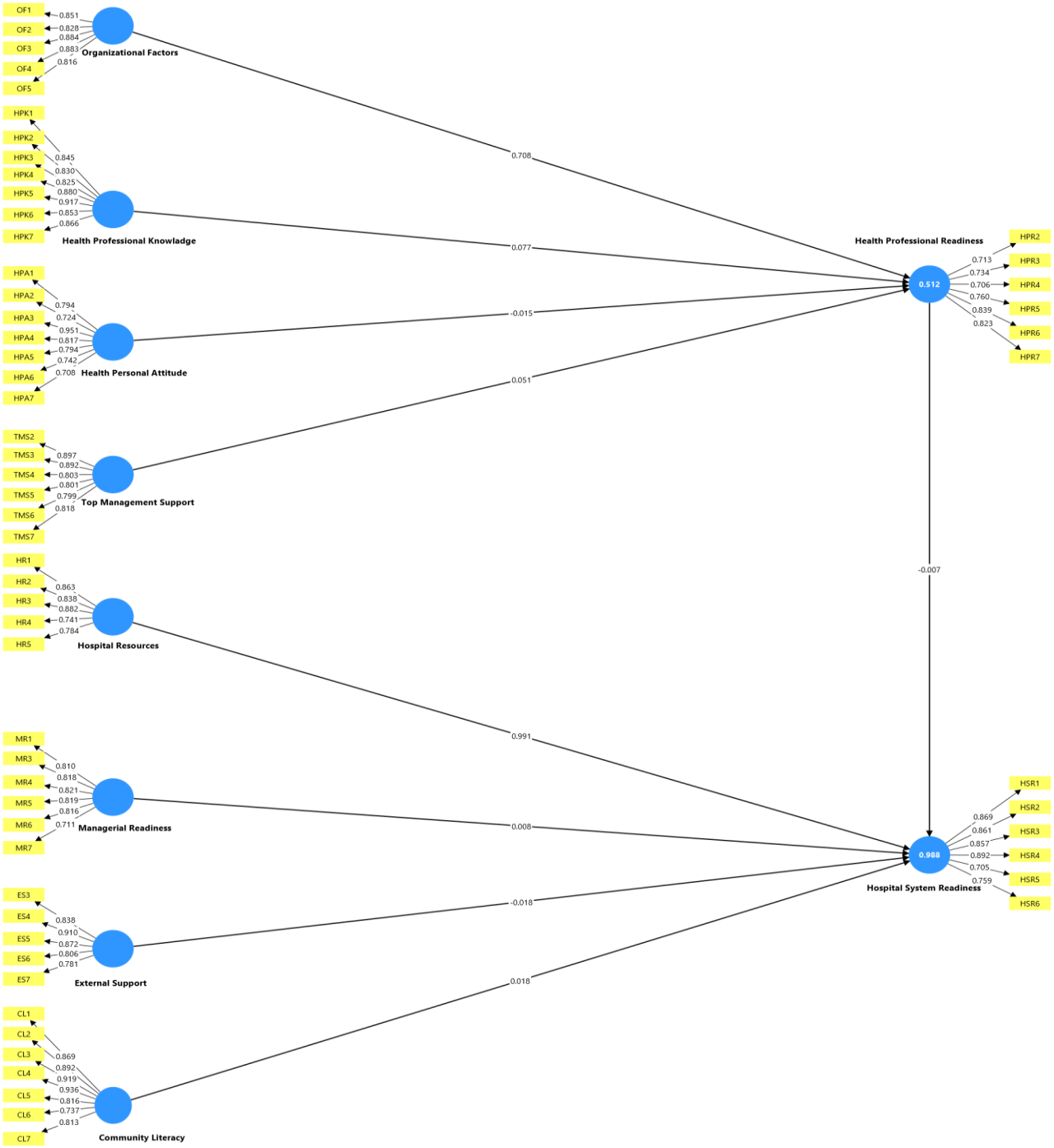

Figure 2. Outer model

The figure above is a visualization of the results of the outer model test, showing that the items used in each variable are valid and reliable, as explained further below:

Table 2. Outer loadings

	Outer loadings
CL1 <- *Community Literacy*	0,869
CL2 <- *Community Literacy*	0,892
CL3 <- *Community Literacy*	0,919
CL4 <- *Community Literacy*	0,936
CL5 <- *Community Literacy*	0,816
CL6 <- *Community Literacy*	0,737
CL7 <- *Community Literacy*	0,813
ES3 <- *External Support*	0,838
ES4 <- *External Support*	0,910
ES5 <- *External Support*	0,872
ES6 <- *External Support*	0,806
ES7 <- *External Support*	0,781
HPA1 <- *Health Professional Attitude*	0,794
HPA2 <- *Health Professional Attitude*	0,724
HPA3 <- *Health Professional Attitude*	0,951
HPA4 <- *Health Professional Attitude*	0,817
HPA5 <- *Health Professional Attitude*	0,794
HPA6 <- *Health Professional Attitude*	0,742
HPA7 <- *Health Professional Attitude*	0,708
HPK1 <- *Health Professional Knowledge*	0,845
HPK2 <- *Health Professional Knowledge*	0,830
HPK3 <- *Health Professional Knowledge*	0,825
HPK4 <- *Health Professional Knowledge*	0,880
HPK5 <- *Health Professional Knowledge*	0,917
HPK6 <- *Health Professional Knowledge*	0,853
HPK7 <- *Health Professional Knowledge*	0,866
HPR2 <- *Health Professional Readiness*	0,713
HPR3 <- *Health Professional Readiness*	0,734
HPR4 <- *Health Professional Readiness*	0,706
HPR5 <- *Health Professional Readiness*	0,760
HPR6 <- *Health Professional Readiness*	0,839
HPR7 <- *Health Professional Readiness*	0,823
HR1 <- *Hospital Resources*	0,863
HR2 <- *Hospital Resources*	0,838
HR3 <- *Hospital Resources*	0,882
HR4 <- *Hospital Resources*	0,741
HR5 <- *Hospital Resources*	0,784
HSR1 <- *Health System Readiness*	0,869
HSR2 <- *Health System Readiness*	0,861
HSR3 <- *Health System Readiness*	0,857
HSR4 <- *Health System Readiness*	0,892
HSR5 <- *Health System Readiness*	0,705
HSR6 <- *Health System Readiness*	0,759
MR1 <- *Managerial Readiness*	0,810
MR3 <- *Managerial Readiness*	0,818
MR4 <- *Managerial Readiness*	0,821
MR5 <- *Managerial Readiness*	0,819

	Outer loadings
MR6 <- *Managerial Readiness*	0,816
MR7 <- *Managerial Readiness*	0,711
OF1 <- *Organizational Factors*	0,851
OF2 <- *Organizational Factors*	0,828
OF3 <- *Organizational Factors*	0,884
OF4 <- *Organizational Factors*	0,883
OF5 <- *Organizational Factors*	0,816
TMS2 <- *Top Management Support*	0,897
TMS3 <- *Top Management Support*	0,892
TMS4 <- *Top Management Support*	0,803
TMS5 <- *Top Management Support*	0,801
TMS6 <- *Top Management Support*	0,799
TMS7 <- *Top Management Support*	0,818

Based on the outer loadings table, all indicators for each construct have loading values above 0.70, thus being considered convergently valid. The constructs Community Literacy, External Support, Health Professional Attitude, Health Professional Knowledge, Health Professional Readiness, Health System Readiness, Hospital Resources, Managerial Readiness, Organizational Factors, and Top Management Support all demonstrate strong indicator contributions in explaining the latent variables. The highest loading values were found for several indicators, such as CL4 (0.936), HPA3 (0.951), HPK5 (0.917), and TMS2 (0.897), indicating that these indicators are highly representative of their respective constructs. Overall, no indicators needed to be eliminated.

Table 3. Cross loadings

	Community Literacy	External Support	Health Professional Attitude	Health Professional Knowledge	Health Professional Readiness	Health System Readiness	Hospital Resources	Managerial Readiness	Organizational Factors	Top Management Support
CL1	0,869	0,668	0,471	0,362	0,080	0,049	0,035	0,579	0,043	0,648
CL2	0,892	0,639	0,450	0,340	0,011	0,049	0,040	0,566	-0,006	0,591
CL3	0,919	0,657	0,468	0,357	0,067	0,050	0,047	0,573	0,019	0,585
CL4	0,936	0,728	0,467	0,373	0,082	0,071	0,065	0,618	0,037	0,616
CL5	0,816	0,692	0,508	0,369	0,051	0,021	0,019	0,644	0,060	0,593
CL6	0,737	0,756	0,549	0,379	0,083	-0,032	-0,032	0,659	0,033	0,644
CL7	0,813	0,684	0,525	0,376	0,046	0,031	0,022	0,613	0,023	0,625
ES3	0,577	0,838	0,497	0,517	0,065	-0,084	-0,090	0,704	0,008	0,547
ES4	0,657	0,910	0,449	0,423	0,053	-0,083	-0,082	0,695	0,061	0,589
ES5	0,598	0,872	0,389	0,422	0,147	-0,099	-0,099	0,610	0,114	0,547
ES6	0,682	0,806	0,401	0,375	0,081	-0,013	-0,014	0,616	0,080	0,585
ES7	0,736	0,781	0,583	0,442	0,108	-0,049	-0,049	0,676	0,047	0,680
HPA1	0,472	0,523	0,794	0,443	0,026	-0,089	-0,090	0,513	0,008	0,500
HPA2	0,531	0,570	0,724	0,492	0,007	-0,004	-0,004	0,546	-0,018	0,494
HPA3	0,504	0,531	0,951	0,449	0,081	-0,023	-0,021	0,592	0,053	0,599

	Community Literacy	External Support	Health Professional Attitude	Health Professional Knowledge	Health Professional Readiness	Health System Readiness	Hospital Resources	Managerial Readiness	Organizational Factors	Top Management Support
HPA4	0,542	0,543	0,817	0,445	0,030	-0,009	-0,011	0,513	-0,009	0,544
HPA5	0,579	0,622	0,794	0,466	0,015	0,007	0,001	0,587	0,003	0,622
HPA6	0,598	0,608	0,742	0,458	-0,031	-0,019	-0,026	0,603	-0,054	0,636
HPA7	0,600	0,679	0,708	0,448	-0,016	-0,021	-0,024	0,626	-0,010	0,618
HPK1	0,393	0,485	0,453	0,845	0,059	-0,098	-0,094	0,525	-0,037	0,440
HPK2	0,382	0,445	0,416	0,830	0,000	-0,114	-0,117	0,491	-0,107	0,389
HPK3	0,355	0,446	0,428	0,825	0,056	-0,142	-0,137	0,478	-0,010	0,390
HPK4	0,332	0,414	0,432	0,880	0,063	-0,076	-0,072	0,428	0,006	0,385
HPK5	0,318	0,448	0,392	0,917	0,067	-0,090	-0,090	0,435	-0,067	0,406
HPK6	0,300	0,451	0,398	0,853	0,054	-0,102	-0,105	0,417	-0,015	0,422
HPK7	0,359	0,474	0,386	0,866	0,054	-0,131	-0,126	0,509	-0,056	0,367
HPR2	0,101	0,130	0,170	0,116	0,713	-0,055	-0,046	0,156	0,382	0,227
HPR3	0,064	0,080	0,087	-0,043	0,734	-0,066	-0,060	0,100	0,513	0,137
HPR4	0,126	0,161	0,136	0,147	0,706	0,029	0,027	0,224	0,470	0,189
HPR5	0,021	0,054	0,050	0,081	0,760	0,033	0,037	0,136	0,475	0,056
HPR6	-0,010	0,053	-0,001	0,040	0,839	-0,090	-0,084	0,100	0,621	0,010
HPR7	0,019	0,055	0,034	0,013	0,823	-0,066	-0,061	0,116	0,700	0,045
HR1	0,077	-0,102	-0,065	-0,108	-0,063	0,861	0,863	-0,054	-0,074	-0,004
HR2	0,084	-0,019	-0,017	-0,025	-0,042	0,857	0,838	-0,030	-0,025	0,046
HR3	0,016	-0,097	-0,010	-0,100	-0,060	0,892	0,882	-0,133	-0,035	-0,032
HR4	0,016	-0,099	-0,017	-0,102	-0,043	0,705	0,741	-0,103	-0,032	-0,031

	Community Literacy	External Support	Health Professional Attitude	Health Professional Knowledge	Health Professional Readiness	Health System Readiness	Hospital Resources	Managerial Readiness	Organizational Factors	Top Management Support
HR5	0,042	-0,079	-0,014	-0,162	0,025	0,759	0,784	-0,052	0,018	0,025
HSR1	0,098	-0,068	-0,036	-0,110	-0,070	0,869	0,808	-0,047	-0,027	0,002
HSR2	0,077	-0,102	-0,065	-0,108	-0,063	0,861	0,863	-0,054	-0,074	-0,004
HSR3	0,084	-0,019	-0,017	-0,025	-0,042	0,857	0,838	-0,030	-0,025	0,046
HSR4	0,016	-0,097	-0,010	-0,100	-0,060	0,892	0,882	-0,133	-0,035	-0,032
HSR5	0,016	-0,099	-0,017	-0,102	-0,043	0,705	0,741	-0,103	-0,032	-0,031
HSR6	0,042	-0,079	-0,014	-0,162	0,025	0,759	0,784	-0,052	0,018	0,025
MR1	0,520	0,674	0,533	0,464	0,112	-0,085	-0,088	0,810	0,058	0,601
MR3	0,604	0,761	0,472	0,471	0,088	-0,085	-0,087	0,818	0,015	0,692
MR4	0,507	0,568	0,429	0,395	0,225	-0,074	-0,086	0,821	0,173	0,488
MR5	0,446	0,524	0,444	0,429	0,152	-0,046	-0,048	0,819	0,125	0,513
MR6	0,503	0,553	0,433	0,386	0,123	-0,039	-0,045	0,816	0,073	0,495
MR7	0,462	0,510	0,448	0,406	0,189	-0,024	-0,022	0,711	0,103	0,507
OF1	-0,003	-0,005	0,037	-0,050	0,566	-0,036	-0,044	0,044	0,851	0,046
OF2	0,016	0,023	0,065	-0,079	0,547	-0,041	-0,049	0,086	0,828	0,088
OF3	-0,004	0,048	0,026	-0,005	0,675	-0,041	-0,040	0,102	0,884	0,027
OF4	0,033	0,065	0,009	-0,049	0,643	0,012	0,013	0,059	0,883	0,034
OF5	0,086	0,179	0,117	0,029	0,574	-0,052	-0,043	0,159	0,816	0,124
TMS2	0,628	0,616	0,505	0,402	0,166	-0,003	-0,001	0,639	0,102	0,897
TMS3	0,642	0,651	0,560	0,413	0,091	-0,060	-0,061	0,639	0,032	0,892
TMS4	0,567	0,607	0,430	0,332	0,030	-0,018	-0,021	0,559	0,042	0,803

	Community Literacy	External Support	Health Professional Attitude	Health Professional Knowledge	Health Professional Readiness	Health System Readiness	Hospital Resources	Managerial Readiness	Organizational Factors	Top Management Support
TMS5	0,527	0,514	0,456	0,356	0,039	0,039	0,044	0,524	-0,016	0,801
TMS6	0,581	0,592	0,464	0,364	0,066	0,023	0,014	0,581	0,058	0,799
TMS7	0,427	0,460	0,482	0,421	0,114	0,036	0,038	0,558	0,059	0,818

The cross loadings indicate that each indicator has the largest loading value on its original construct compared to other constructs. This indicates that discriminant validity has been met, as the indicators more closely reflect the latent variables they are intended to measure. Although there are some moderate correlations between constructs, these values remain lower than the primary loadings on the original constructs. Thus, the model meets both the Fornell-Larcker and cross-loading criteria as indicators of discriminant validity.

In this section, you should present the conclusion of the paper. Conclusions must focus on the novelty and exceptional results you acquired. Allow a sufficient space in the article for conclusions. Do not repeat the contents of the Introduction or the Abstract. Focus on the essential things of your article.

Table 4. Validity and reliability

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Community Literacy	0,950	0,951	0,734
External Support	0,902	0,924	0,710
Health Professional Attitude	0,947	0,922	0,630
Health Professional Knowledge	0,943	0,952	0,739
Health Professional Readiness	0,858	0,893	0,584
Health System Readiness	0,905	0,928	0,683
Hospital Resources	0,880	0,913	0,678
Managerial Readiness	0,894	0,914	0,640
Organizational Factors	0,906	0,930	0,727
Top Management Support	0,921	0,933	0,699

The Cronbach's alpha, composite reliability, and AVE values for all constructs are above the recommended minimum threshold ($\alpha > 0.70$, CR > 0.70, AVE > 0.50). This indicates that the research instrument is reliable and has good convergent validity. The Health Professional Knowledge construct has the highest AVE (0.739), indicating excellent measurement quality. Overall, all latent variables meet internal reliability criteria and adequately explain the variance in their indicators.

After evaluating the outer model, which includes the validity and reliability of the indicators for each construct, it can be seen that all indicators have adequate outer loadings and meet the AVE and composite reliability standards. This indicates that the indicators used in this study are able to validly and reliably measure constructs such as Community Literacy, External Support, Health Professional Attitude, Health Professional Knowledge, Health Professional Readiness, Hospital Resources,

Managerial Readiness, Organizational Factors, and Top Management Support. With convergent and discriminant validity assured, the next step is to test the inner model to evaluate the structural relationships between constructs and to observe the influence of these factors on health worker readiness (Health Professional Readiness) and Health System Readiness (Health System Readiness). The transition from the outer model to the inner model allows analysis not only at the level of indicator measurement but also at the level of causal relationships between latent variables, thus providing a deeper understanding of the main determinants that influence individual and system readiness in the context of dengue control. The following is a visualization of the results of the inner model test that has been conducted:

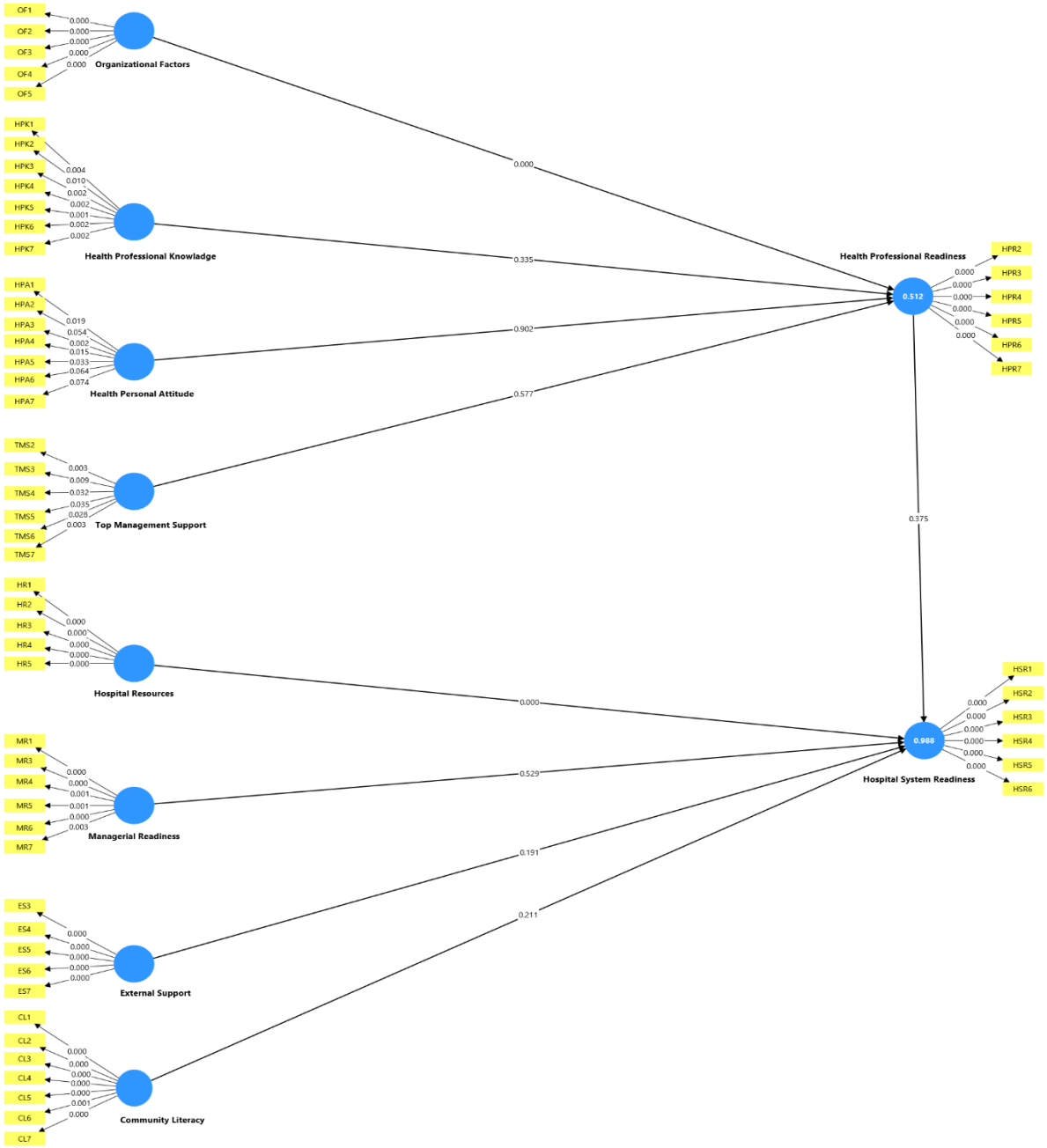

Figure 3. Inner model

The inner model visualization results show the structural relationships between the constructs that are the focus of this study. It can be seen that Organizational Factors have the strongest influence on Health Professional Readiness, while individual factors such as Health Professional Knowledge and Health Professional Attitude have a relatively smaller and insignificant influence. Meanwhile, at the system level, Hospital Resources emerged as the dominant construct influencing Health System Readiness, while other factors such as Community Literacy, External Support, and Managerial Readiness contributed less. This visualization also shows a relationship between health worker readiness and Health System Readiness, but the influence is relatively weak when compared to the influence of resources and Organizational Factors. Thus, the inner model shows that individual and Health System Readiness are more influenced by structural factors and institutional resources than personal factors. Therefore, interventions to improve readiness should focus on strengthening organizational capacity and hospital facilities.

Table 5. VIF

	VIF
Community Literacy -> Health System Readiness	2,350
External Support -> Health System Readiness	3,378
Health Professional Attitude -> Health Professional Readiness	1,655
Health Professional Knowledge -> Health Professional Readiness	1,402
Health Professional Readiness -> Health System Readiness	1,037
Hospital Resources -> Health System Readiness	1,052
Managerial Readiness -> Health System Readiness	2,662
Organizational Factors -> Health Professional Readiness	1,013
Top Management Support -> Health Professional Readiness	1,629

The VIF values for all structural relationships are below the maximum limit of 5, indicating that there is no multicollinearity affecting the model estimation. The highest values are found for External Support → Health System Readiness (3.378) and Managerial Readiness → Health System Readiness (2.662), but these are still within acceptable limits. Thus, the relationships between constructs can be safely interpreted without the risk of bias due to collinearity.

Table 7. R-Square

	R-square	R-square adjusted
Health Professional Readiness	0,512	0,502
Health System Readiness	0,988	0,987

The Health Professional Readiness construct has an R-square value of 0.512, indicating that its predictor variables explain 51.2% of the variation in Health Professional Readiness. Meanwhile, Health System Readiness has a very high R-square value of 0.988, meaning that 98.8% of the variability in Health System Readiness can be explained by the constructs that influence it. This is considered substantial, indicating that the model has very strong structural predictive power for this variable.

Table 8. F-Square

	f-square
Community Literacy -> Health System Readiness	0,012
External Support -> Health System Readiness	0,008
Health Professional Attitude -> Health Professional Readiness	0,000
Health Professional Knowledge -> Health Professional Readiness	0,009
Health Professional Readiness -> Health System Readiness	0,004
Hospital Resources -> Health System Readiness	76,151
Managerial Readiness -> Health System Readiness	0,002
Organizational Factors -> Health Professional Readiness	1,014
Top Management Support -> Health Professional Readiness	0,003

The F-square value illustrates the magnitude of each construct's influence on the dependent variable. The results show that Hospital Resources → Health System Readiness has a very large effect size (76.151), making it the most dominant contributor in

the model. Organizational Factors → Health Professional Readiness also has a large effect (1.014). Meanwhile, other variables such as Community Literacy, External Support, Health Professional Attitude, Health Professional Knowledge, and Top Management Support showed small to very small effect sizes (0.000–0.012), indicating a relatively weak influence on the intended construct.

The Q^2predict value for Health Professional Readiness was 0.469, indicating moderate to strong predictive capability. Meanwhile, the Q^2predict for Health System Readiness reached 0.988, indicating that the model has very high predictive capability for Health System Readiness. Overall, this PLS-SEM model has very good predictive relevance.

Table 9. Q-Square

	Q^2predict
Health Professional Readiness	0,469
Health System Readiness	0,988

Table 10. Hypothesis significant testing

Code	Hypothesis	Original Sample (O)	T-Statistics	P-Value	Description
H1	*Organizational Factors → Health Professionals' Readiness*	0,708	14,638	0,000	Significant (Supported)
H2	*Health Professional Knowledge → Health Professionals' Readiness*	0,077	0,963	0,335	Insignificant (Not supported)
H3	*Health Professional Attitude → Health Professionals' Readiness*	-0,015	0,123	0,902	Insignificant (Not supported)
H4	*Top Management Support → Health Professionals' Readiness*	0,051	0,557	0,577	Insignificant (Not supported)
H5	*Hospital Resources → Health Systems Readiness*	0,991	312,116	0,000	Significant (Supported)
H6	*Managerial Readiness → Health Systems Readiness*	0,008	0,629	0,529	Insignificant (Not supported)
H7	*External Support → Health Systems Readiness*	-0,018	1,307	0,191	Insignificant (Not supported)
H8	*Community Literacy → Health Systems Readiness*	0,018	1,250	0,211	Insignificant (Not supported)
H9	*Health Professionals' Readiness → Health Systems Readiness*	-0,007	0,887	0,375	Insignificant (Not supported)

The path analysis results showed that of the nine hypotheses proposed, only two were found to be significant. First, Organizational Factors had a positive and significant effect on Health Professionals' Readiness (H1), with a coefficient of 0.708 and a p-value of 0.000. This finding indicates that Organizational Factors, such as structure, work culture, and institutional policies, play a significant role in improving healthcare professional readiness. Furthermore, Hospital Resources proved to have a positive and highly significant effect on Health Systems Readiness (H5), indicated by a very high coefficient (0.991) and a p-value of 0.000. This confirms that the availability of Hospital Resources, including facilities, infrastructure, and human resources, is a key determinant of healthcare system readiness.

Meanwhile, several other hypotheses did not show significant effects. Neither Health Professional Knowledge (H2) nor Health Professional Attitude (H3) was shown to influence Health Professionals' Readiness, with p-values of 0.335 and 0.902, respectively. Similarly, Top Management Support (H4) did not significantly influence healthcare professional readiness. This indicates that individual factors such as knowledge, attitudes, and Top Management Support are not strong enough to improve healthcare professional readiness without structural support from Organizational Factors.

In addition to Hospital Resources, other variables such as Managerial Readiness (H6), External Support (H7), Community Literacy (H8), and Health Professionals' Readiness (H9) also did not contribute significantly to the pathway to Health Systems Readiness. Therefore, these relationships are not supported by empirical data. These results indicate that healthcare system readiness is more determined by Hospital Resources than by Managerial Readiness, External Support, Community Literacy, or the readiness of healthcare workers themselves.

Overall, these findings confirm that structural factors and resources, particularly those within the organization and healthcare facilities, have a dominant influence over individual or external factors in shaping healthcare worker and healthcare system readiness. These findings provide important implications for policymakers: improving system readiness needs to focus on strengthening Hospital Resources and organizations.

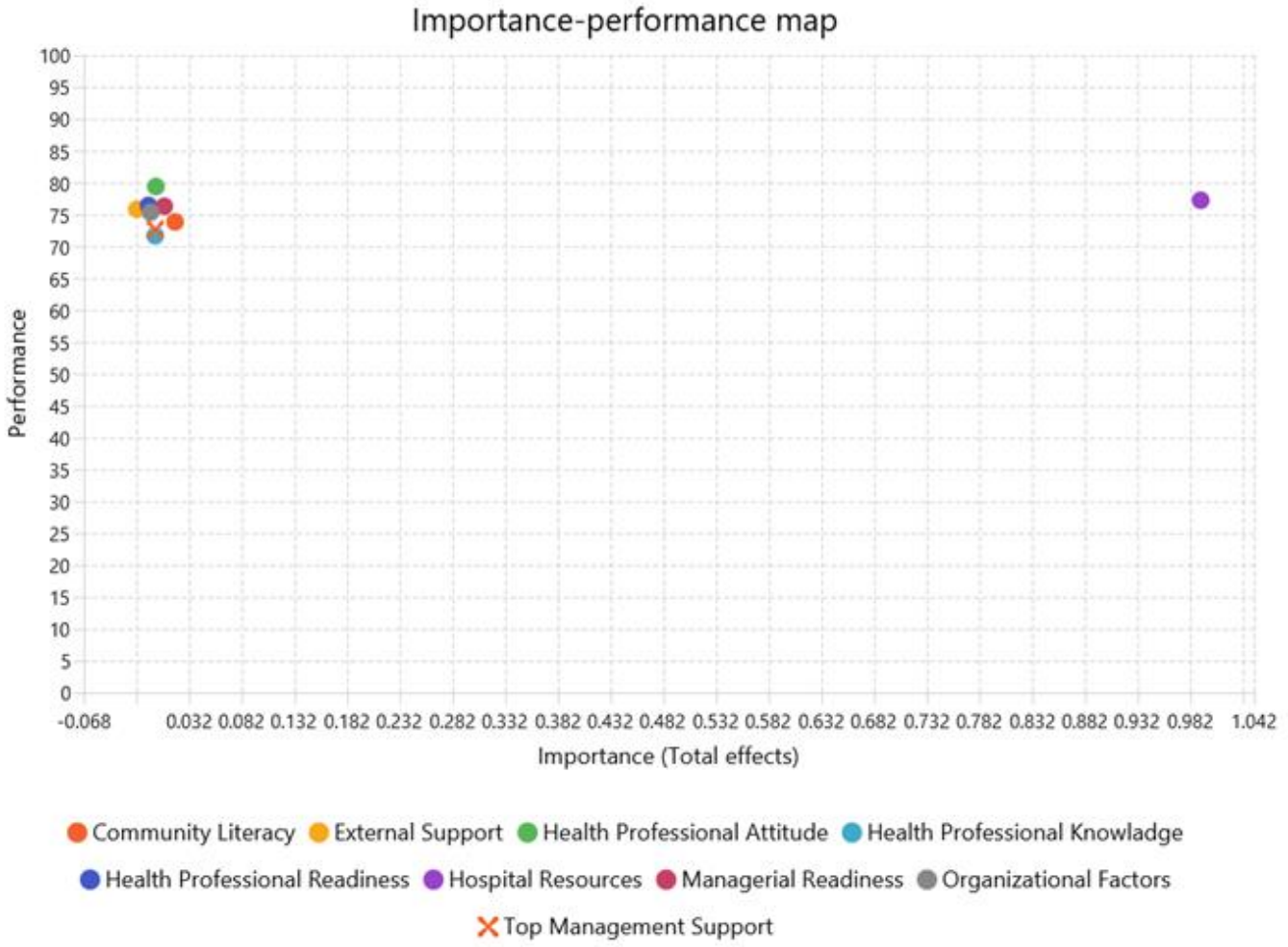

Figure 4. IPMA

The IPMA analysis aims to identify which variables have the most important influence (importance) and highest performance in improving Health System Readiness. IPMA results indicate that each construct has a different contribution (total effect) and level of performance, thus it can be used to determine intervention priorities.

The results indicate that Hospital Resources is the most influential factor on Health System Readiness,

indicated by a very large total effect of 0.991. This value is much higher than other constructs, which generally fall below 0.02 or even approach zero. This indicates that Health System Readiness is largely determined by the adequacy of hospital facilities, infrastructure, equipment, and resources. In terms of performance, Hospital Resources scored 77.252, categorized as high performance. With its already strong performance, further strengthening of Hospital Resources will significantly improve Health System Readiness.

Constructs such as Community Literacy (0.018), Managerial Readiness (0.008), Organizational Factors (-0.005), Health Professional Readiness (-0.007), and External Support (-0.018) have very low importance values for Health System Readiness. Although some constructs performed relatively well (e.g., Community Literacy = 73.850; Managerial Readiness = 76.298), their impact on improving Health System Readiness remains minimal. This indicates that focusing on these constructs will not significantly impact Health System Readiness.

Constructs related to individuals, such as Health Professional Attitude (0.000) and Health Professional Knowledge (-0.001), have almost no significant contribution to Health System Readiness. Despite their relatively good performance (HPA = 79.401, the highest of all constructs; HPK = 71.689), improvements in these aspects will not directly improve Health System Readiness. This indicates that the health system is more influenced by structural factors and Hospital Resources than by personnel factors.

Based on the importance-performance map, the constructs that should be the top priority for improvement are Hospital Resources (Highest importance, high performance), which should be maintained and improved because they provide the greatest impact. Meanwhile, other constructs, despite their good performance, are not strategic priorities due to their low contribution. Improvement efforts on constructs such as Community Literacy, Top Management Support, or Organizational Factors do not provide significant added value to Health System Readiness.

The results of the study showed only two significant relationships: the influence of Organizational Factors on Health Professionals' Readiness and the influence of Hospital Resources on Health System Readiness. This finding aligns with numerous international studies emphasizing that the healthcare workforce and Health System Readiness are primarily determined by structural, organizational, and resource-availability aspects, rather than solely by individual factors.

First, the significant finding that Organizational Factors have a strong influence on Health Professionals' Readiness aligns with the research of Kruszyńska-Fischbach et al. (2022), who stated that organizational readiness is the primary foundation for ensuring healthcare workforce readiness for service transformation, including changes in technology and work systems. They emphasized that organizational structure, work culture, and internal policies provide direct support for HR readiness in healthcare facilities. The same finding was confirmed by Yassen et al. (2023), who found that healthcare workforce readiness is significantly influenced by organizational support, particularly in the context of e-health. Organizations that are more prepared managerially, structurally, and policy-wise have been shown to improve medical staff readiness. Thus, the findings of this study reinforce the literature that improving healthcare professional readiness is not solely achieved through improving individual competencies but must be supported by a supportive organizational environment.

Second, the significant influence of Hospital Resources on Health System Readiness aligns with research by Bagahizel & Elkhatim (2023), which indicates that healthcare facility resource capacity is the most crucial factor in outbreak preparedness, including the availability of treatment rooms, medical personnel, logistics, and coordination systems. Similarly, Malik et al. (2021) emphasized that the successful management of a dengue outbreak in Pakistan was highly dependent on the readiness of hospital facilities and an adequate emergency management system. Research by Mboera et al. (2021) also found that healthcare system readiness in responding to a dengue epidemic was largely determined by the strength of healthcare facilities, including infrastructure, laboratory capacity, medical logistics, and coordination capabilities between

healthcare units. The IPMA findings in this study, which ranked Hospital Resources as the factor with the highest importance (0.991) and high performance, are consistent with the literature that places healthcare facility resources as a strategic factor in system readiness.

Meanwhile, the research findings, which show that individual factors such as Health Professional Knowledge, Health Professional Attitude, and Top Management Support have no significant effect on Health Professionals' Readiness, align with the findings of several studies that suggest that healthcare workers' knowledge and attitudes do not directly determine their readiness to adopt systems or navigate change. Ngusie et al. (2022) and Biruk et al. (2014) found that even though healthcare workers have positive knowledge and attitudes toward adopting electronic systems, their readiness remains low when the organization does not provide support systems, training, and a conducive work environment. Therefore, the low influence of individual factors in this study indicates that healthcare worker readiness is structure-driven, rather than knowledge-driven or attitude-driven.

Regarding the pathway to Health System Readiness, the insignificant results of Managerial Readiness, External Support, Community Literacy, or Health Professional Readiness confirm that Health System Readiness does not always depend on individual readiness or External Support. Salehi et al. (2025) emphasized that Health System Readiness in managing dengue is determined more by internal structural capabilities, rather than solely by external support or social aspects of the community. Another finding from Rajapaksha & Wickramasinghe (2021) also shows that even though hospital managers have a high level of preparedness, overall system readiness remains dependent on physical infrastructure and resources. In fact, research by Wubante et al. (2022) found that healthcare worker readiness does not automatically improve system readiness if it is not accompanied by institutional support and policies. Therefore, the insignificance of the External Support and Community Literacy pathways to Health System Readiness in this study is quite reasonable, considering that global literature also shows that successful system readiness depends on internal foundations, not external factors.

From an IPMA perspective, the construction of Hospital Resources emerged as the most crucial factor in improving Health System Readiness, a finding consistent with global empirical evidence. Pang et al. (2017) stated that strengthening health facilities and hospital response capabilities is the most crucial element in national dengue control. Moreover, Alwan et al.'s (2023) report on country readiness for essential health service packages emphasized that the successful implementation of health services depends heavily on the readiness of physical and logistical resources, not just the readiness of health workers or External Support. Therefore, this IPMA study draws strong support from global research, which emphasizes that priority improvement should focus on strengthening hospital capacity and resources.

Overall, this study's findings are consistent with a large body of international literature showing that health system and health worker readiness are more influenced by structural and Organizational Factors than individual or social factors. In addition to providing empirical validation, these findings also indicate that strategies to improve Health System Readiness should focus on strengthening the organization and resources of health facilities, rather than solely on the knowledge or attitudes of health workers.

Conclusion

This study concluded that Health Professional Readiness and Health System Readiness are significantly influenced by structural factors at the organizational and facility levels. At the individual level, neither knowledge, attitudes, nor Top Management Support significantly influenced Health Professional Readiness. Conversely, Organizational Factors emerged as the primary determinant, strongly influencing Health Professional Readiness. These findings suggest that organizational support, internal governance, work culture, and operational policies play a greater role in shaping Health Professional Readiness than individual cognitive or affective factors.

At the health system level, Hospital Resources were the only factor with a significant and significant influence on Health System Readiness. Health System

Readiness was not affected by External Support, Community Literacy, Managerial Readiness, or health worker readiness. This indicates that the capacity of hospital facilities, infrastructure, logistics, and internal resources is the primary foundation of system readiness in facing challenges, including potential outbreaks. The IPMA results further support these findings, with Hospital Resources receiving the highest importance rating and performing well, making them a strategic priority in readiness improvement planning. Overall, this study confirms that readiness at both levels is structure-driven, so intervention strategies should focus on strengthening the organization and resources of health facilities.

This study has several limitations that require consideration when interpreting the results. First, the study design used a cross-sectional approach, making it unable to describe changes in readiness over time or establish deeper causal relationships. Second, the study relied on respondent perception data through questionnaires, which are potentially influenced by subjective biases such as social desirability bias. Third, this study focused on specific variables, so it is possible that other important factors were not accounted for, such as leadership capacity, government regulatory factors, or external dynamics that could influence readiness. Fourth, the study was conducted in a specific geographic or institutional context, so generalizing the results to other regions or health systems should be done with caution.

Future research is recommended to develop a longitudinal design to observe dynamic changes in readiness and more robustly test causal relationships. Future research should also include other variables relevant to system and healthcare workforce readiness, such as regulatory factors, technological readiness, leadership capacity, cross-sector coordination, and public health policy support. Additionally, a mixed-methods approach can be used to enrich the quantitative findings with in-depth interviews or field observations, providing a more comprehensive picture of readiness aspects. The research can also be expanded to different institutional and regional contexts to increase the generalizability of the findings. Finally, an evaluation of interventions based on strengthening Hospital Resources and strengthening the organization can be conducted to test the effectiveness of the readiness improvement strategies generated by this study.

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