ICT Maturity Assessment at Primary Healthcare Services across 9 Provinces in Indonesia: An Evaluation Study

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Abstract

Background: Indonesia has rapidly embraced digital health, particularly during the COVID-19 pandemic, with over 15 million daily health application users. To advance its digital health vision, the government is prioritizing the development of health data and application systems into an integrated healthcare technology ecosystem. This initiative involves all levels of healthcare, from primary to tertiary, across all provinces. In particular it aims to enhance primary healthcare services (as the main interface with the general population) and contribute to Indonesia's digital health transformation.

Objective: This study assesses the information and communication technology (ICT) maturity in Indonesian healthcare services to advance digital health initiatives. ICT maturity assessment tools were utilized, specifically designed for developing countries, to evaluate digital health capabilities in 9 provinces across 5 Indonesian islands.

Methods: A cross-sectional survey was conducted in 2022, in 9 provinces across Indonesia, representing the country's diverse conditions on its major islands. Respondents included staff from Public Health Centers (Puskesmas), Primary Care Clinics (Klinik Pratama), and District Health Offices (Dinas Kesehatan Kabupaten/Kota). The survey used adapted ICT maturity assessment questionnaires, covering human resources, software and system, hardware, and infrastructure. It was administered electronically and involved 121 Public Health Centers, 49 Primary Care Clinics, and 67 IT staff from District Health Offices. Focus group discussions were held to delve deeper into the assessment results and gather more qualitative insights.

Results: In this study, 237 participants represented three distinct categories: 121 Public Health Centers, 67 District Health Offices, and 49 Primary Clinics. These instances were selected from a sample of 9 out of the 34 provinces in Indonesia. Collected data from interviews and focus group discussions were transformed into scores on a scale of 1 to 5, where 1 indicates low ICT readiness, and 5 indicates high readiness. On average, the breakdown of ICT maturity scores is as follows: human resource capability and system management (2.71), software and information systems (2.83), hardware (2.59), and infrastructure (2.84), resulting in an overall average score of 2.74. According to the ICT Maturity level pyramid, the ICT maturity of healthcare providers in Indonesia falls between the basic and good levels. The need to pursue best practices also emerged strongly. Further analysis of the ICT Maturity Scores, when examined by province, revealed regional variations.

Conclusions: The maturity of ICT utilization is influenced by several critical components. Enhancing human resources, ensuring infrastructure and the availability of supportive hardware, and optimizing information systems are imperative to attain ICT maturity in healthcare services. In the context of ICT Maturity assessment, significant score variations are observed across healthcare levels in nine provinces, underscoring the diversity in ICT readiness, and need for regionally-customized follow-up actions.

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ABSTRACT

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A cross-sectional survey was conducted in February - March 2022, in 9 provinces across Indonesia, representing the country's diverse conditions on its major islands. Respondents included staff from Public Health Centers (Puskesmas), Primary Care Clinics (Klinik Pratama), and District Health Offices (Dinas Kesehatan Kabupaten/Kota). The survey used adapted ICT maturity assessment questionnaires, covering human resources, software and system, hardware, and infrastructure. It was administered electronically and involved 121 Public Health Centers, 49 Primary Care Clinics, and 67 IT staff from District Health Offices. Focus group discussions were held to delve deeper into the assessment results and gather more descriptive insights.

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Keywords

Public health centers; Puskesmas; digital maturity; infrastructure; primary healthcare; district health

office; primary care clinics

Introduction

Digital health plays a significant role in enhancing healthcare services for people and has developed beyond providing just electronic health records to supporting healthcare services provision, health surveillance, health literature, health research, and also data-driven health policies.[1-4] The massive growth of technology usage in health propelled to the top of the global agenda as summarized in the World Health Organization's (WHO) Global Strategy on Digital Health 2020-2025.[1] According to this report, each country is expected to adopt the strategies best suited to its conditions, culture, and values in order to reach it's digital health sustainability.

In 2022, the Ministry of Health (MoH) of the Republic of Indonesia launched its health system transformation strategy. There are six pillars of the transformation strategy, and one of them is primary health care transformation, which in its implementation focuses on strengthening promotive and preventive activities to create more healthy people, improve health screening, and increase primary service capacity. Healthcare services in Indonesia are primarily provided at a public healthcare facility called Puskesmas, short for Pusat Kesehatan Masyarakat or Public Health Centers and community based public health service (Posyandu) since the 1980s.

Puskesmas in Indonesia spread across all types of characteristic regions such as urban, rural, remote, and very remote in Indonesia within all 38 provinces and 514 districts/cities. The number of Puskesmas has increased since 2017, from 9,825 units to 10,374 Puskesmas in 2022. The ratio of Puskesmas in Indonesia to sub-districts in 2022 is 1.4. This illustrates that the ideal ratio of Puskesmas to sub-districts, namely a minimum of 1 Puskesmas in 1 sub-district, has been fulfilled nationally. In terms of an average ratio, each Puskesmas serves 27,000 – 30,000 thousand residents in 2023.

Puskesmas serves two main functions, which are to provide integrated individual healthcare services and essential public health services. Other tasks of Puskesmas are to provide continuous and comprehensive care, to refer patients to specialists and hospital services, coordinate health services, and guide the patient within the network of public health services. Puskesmas play roles on promotive, preventive, curative for the population, while primary clinics and other primary health services such as private general practitioner (DPM) and private midwife (BPM) are more focused on curative and specific health services approaches. Other than that, Puskesmas also has a responsibility to provide technical guidance to primary clinics, DPM, and BPM as the networking partner institutions in the area. Beside Puskesmas and Posyandu, essential health services are provided by other primary care centers such as clinics, private general practitioner (DPM) and private midwife (BPM). In 2023, the primary care clinics also increasingly grew and reached more than 11,000 units, while DPM and BPB reached 5,800 plus across all 38 provinces in Indonesia.

In terms of organizational governance, Puskesmas is a part of the District Health Office as the technical implementation unit (UPT). In this case, the district health office is responsible for providing guidance, monitoring and evaluation for Puskesmas in its region. However, Puskesmas has autonomy in order to synchronize and harmonize the health development goals in its working area. All health services activity in the area conducted by Puskesmas and its networking partner (primary clinics, DPM, and BPM) coordinated and reported by Puskesmas to the District Health Office on annually, monthly, and weekly basis by using an electronic or non-electronic system that includes a) Activity report; b) Financial report; c) Field survey report; d) Related cross-sector reports; and e) The health services network (clinics, DPM, BPM) report in the area. This reporting scheme continued by the district health office to the province health office and to the ministry of health as the national authority.

The health services and public health programs that are being routinely reported using an electronic information system range from maternal and child health, nutrition, surveillance, disease prevention and control with multiple and separated different applications that are not supported yet with interoperability data standards. Besides that, there are multiple electronic medical record (EMR) systems widely developed by hundreds of private vendors as the specific system to provide a patient medical record to healthcare called called "*Sistem Informasi Puskesmas* (*SIMPUS)* for Puskesmas, SIMKLINIK for primary clinic, including telemedicine and tele consultation platform that is still integrated and interoperable with the other public health information system developed by the Ministry of Health.

Indonesia has pursued continuous improvements in the national digital health implementation. To this end, the COVID-19 pandemic accelerated the introduction of national digital health capacity and raised the number of daily health applications users, currently exceeding 15 million people.[5,6] Through the launch of the Blueprint of Digital Health Transformation Strategy 2024, the government committed to using digital technology and data for public health, to support the realization of a healthy Indonesia. The priority of Indonesia's digital health transformation activities are: including integration and development of health data, integration and development of application systems, and health technology ecosystem development. Those transformations will collect standardized health data into a centralized platform named Satu Sehat (One Health Data). They start with the laying of health data architecture design and interoperability, and the assessment of current infrastructure and security levels.[7]

Implementing such a large-scale digital transformation requires technical maturity by the health sectors' information and communication technology (ICT). The critical factors of ICT maturity include: infrastructure, policies, human capital development, change management, strategy, leadership, partnership, and collaboration.[8] In 2017, the Ministry of Health used the Health Metrics Network-World Health Organization (HMN-WHO), as the basis for national e-health strategic framework, incorporating a holistic approach in planning, developing, implementing, and evaluating the usage of ICT in health services. The strategic framework contains seven components: (1) governance and leadership, (2) strategy and investment, (3) services and application, (4) standards and interoperability, (5) infrastructure, (6) legislation, policy, and compliance, and (7) workforce. [2,9]

Chanyagorn and Kungwannarongkun (2011) developed an ICT maturity assessment tool to explore ICT readiness in small and medium-sized organizations in developing countries (both public and private sectors). The assessment tool evaluates the ability of consumers, businesses, and governments to utilize ICT to their advantage, whereas this paper studies ICT maturity assessment in sample governmental public health services facilities and institutions. The most significant aspect of this tool is the assessment of maturity for various aspects, as it can be adjusted to best reflect the different mix of conditions in developing countries, such as Indonesia. The tool assesses four main ICT factors: (1) Infrastructure, (2) Hardware, (3) Software and System information, and (4) People and Human Resources.[10]

Therefore, as part of the digital health development in Indonesia, it is important to understand the ICT maturity level in healthcare services immediately post-pandemic, as a benchmark for future ICT initiatives. This study focused its assessment on the ICT maturity across primary healthcare services and district health offices in Indonesia, applying the ICT maturity assessment tool for developing countries. To maintain a high level of inclusivity of services across different geographical regions, the evaluation of digital health capability was investigated in 9 provinces, spread over the 5 biggest

islands in Indonesia. This study is the first study that assesses the ICT maturity through developing country approach for Public Health Centers, Primary Clinics, and District Health Offices.

Methodology

Data Collection

A cross-sectional survey design involving the ICT maturity assessment tool for developing countries was employed in nine provinces in Indonesia. Targeted stratified sampling was applied to choose the participants from five big islands in the country. DKI Jakarta, West Java, Banten, and East Java provinces on Java Island; Aceh province on Sumatra Island; East Kalimantan province on Kalimantan Island; Central Sulawesi province in Sulawesi Island; West Nusa Tenggara on the Nusa Tenggara Islands; and Maluku province from Maluku and and Papua Islands. Provinces chosen in five big islands were based on region representativeness and health facility characteristics which weare urban, rural, and remote areas.

The targeted respondents were representatives of three main health sites in the province, including Public Health Centers (Puskesmas), Primary Care Clinics (Klinik Pratama), and District Health Offices (Dinas Kesehatan Kabupaten/Kota). A letter of invitation was sent to the targeted Province District Health Office as the official invitation for online survey and FGD session. Each participant involved during the survey and FGD was based on top management assignment to attend the online survey and FGD meeting. To address the participants selection and response biases, all assigned participants from all regions need to fulfill some inclusion criteria for the respondents, including: (1) the personnel that handle and oversee the implementation of HIS in each site, (2) had knowledge of HIS used in the health site, and (3) had the ability to communicate with local staff to complete the survey accurately.

An ICT maturity assessment questionnaire was adopted and modified adjusting to the local country situation. The modification was made in the question of each ICT subcomponent, especially on organization knowledge component, software security and document component, and network security component (see Figure 1). A pilot survey test was conducted with 20 participants to gain feedback from participants ensuring the questions were easy to understand, learning how long does it take to fulfill the questionnaire, and capturing suggestions to improve the assessment form. The questionnaire (see Multimedia Appendix 1) consisted of four sections: (i) human resource, covering availability of trained personnel for data entry, data analysis, and IT personnel, transfer knowledge process, and personnel training; (ii) software and systems, covering the number of Health Information Systems (HIS) used, data reporting in the HIS, and troubleshoot and maintenance performance; (iii) hardware, including the availability of PC/laptop, servers, storage, manual entry data; and (iv) infrastructure, including internet access availability, the availability of electricity, and physical facility/building (see Figure 1).

The survey was conducted by gathering the respondents through online meetings. The process was completed between February and March 2022. There were 237 respondents that were divided into seven FGDs with each FGDs facilitated with five facilitators. The data was collected through two sessions in the meetings, which took 2.5 hours to complete: (1) filled out the questionnaire form for the quantitative score; and (2) forum group discussion (FGD) session to discuss the survey findings and explore deeper into the assessment results obtained. Each individual component of the ICT maturity questionnaire was discussed in more detail to obtain more comprehensive qualitative information. Discussions were continued until thematic saturation was reached.

Data Analysis

The ICT maturity assessment tool consisted of fourteen sub-sections containing 30 questions [Appendix 1]. The participants' responses to these questions were categorized into five levels of

digital maturity: (1) Initial, (2) Basic, (3) Good, (4) Best Practice, and (5) Excellent (see Figure 2), a score of 1 indicating the lowest level of Digital Maturity (Initial), and 5 representing the highest (Excellent). The online survey responses were recorded by our team using the Mentimeter forms database tools, and the FGD results were input in a table using Microsoft Excel. The scores of each participating organization, including Public Health Centers, Primary Care Clinics, and District Health Offices, were utilized to determine their ICT maturity levels. The organization's score was calculated and averaged for each province.

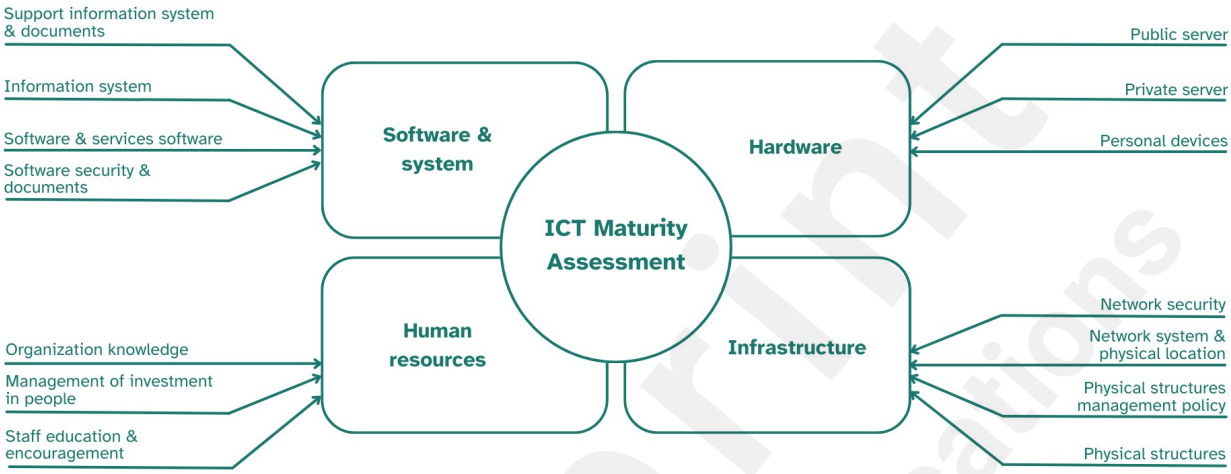

Figure 1. The modified components evaluated in the ICT Maturity Assessment

The analysis was performed in Microsoft Excel. The scores from the four components were used to produce the mean score. A comparison analysis at districts and provinces level was also generated. The FGD was recorded and qualitative information obtained from participants was categorized based on the ICT component to be summarized as the FGD results for all provinces.

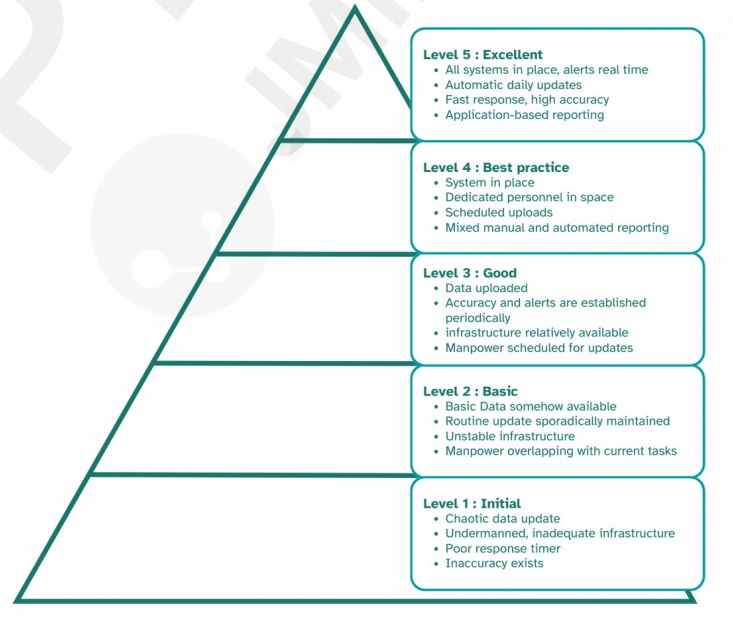

Figure 2. ICT Maturity Level

Ethical Considerations

We declare that the data collected for this paper do not require ethical approval as no individual data are presented, and informed consent was collected during the survey implementation.

Results

The study respondents were 237 in total and included 121 representatives of Public Health Centers, 67 information technology (IT) staff from District Health Offices, and 49 Primary Care Clinic staff (see Table 1). The provinces of East Java, Aceh, East Kalimantan, and West Nusa Tenggara had the largest representation among the participating Public Health Centers, with 27, 17, 15, and 15 Public Health Centers from each province, respectively. As for the District Health Offices, Aceh, West Nusa Tenggara, and East Kalimantan each had 11, 9, and 9 District Health Offices, while East Java had the highest representation with 13 District Health Offices. Notably, representatives from West Nusa Tenggara led the Primary Care Clinic segment, accounting for 12 Primary Care Clinics, followed by East Java with 9 Primary Care Clinics and Aceh with 8 Primary Care Clinics.

Table 1. The Study Participants

No	Island	Province	Public Health Center	District Health Office	Primary Care Clinic	Subtotal
1	Java	DKI Jakarta	6	5	1	12
2	Java	West Java	13	6	5	24
3	Java	Banten	5	2	1	8
4	Sumatra	Aceh	17	11	8	36
5	Java	East Java	27	13	9	49
6	Nusa Tenggara	West Nusa Tenggara	15	9	12	36
7	Kalimantan	East Kalimantan	15	9	6	30
8	Sulawesi	Central Sulawesi	11	8	2	21
9	Maluku	Maluku	12	4	5	21
		TOTAL	**121**	**67**	**49**	**237**

On average, the ICT maturity scores are broken down as follows: human resource (2.71), software and systems (2.83), hardware (2.59), and infrastructure (2.84), resulting in an overall average score of 2.74 (see Figure 3). Based on the analysis, health care providers in Indonesia have ICT maturity between basic and good, in accordance with the ICT maturity level pyramid.

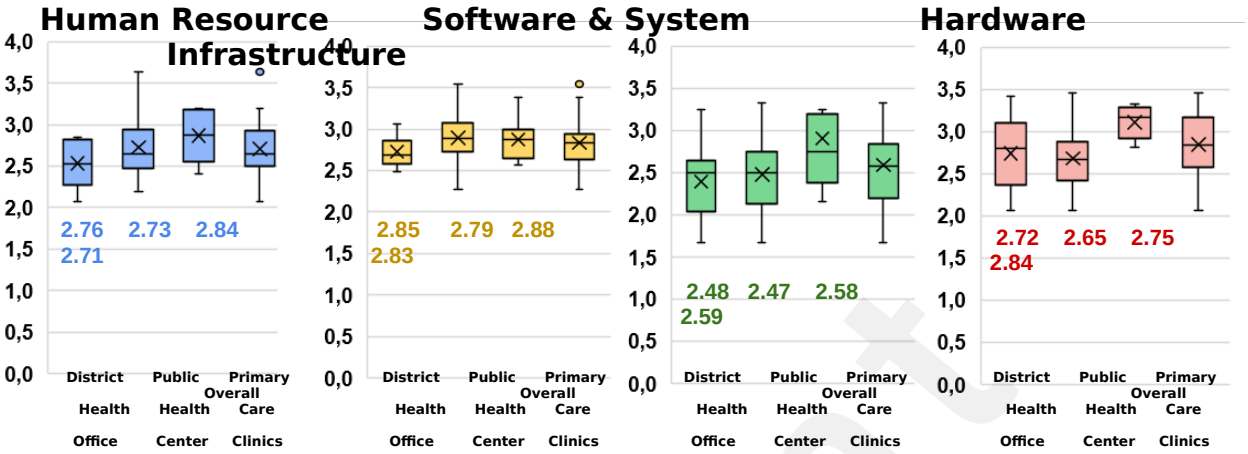

Figure 3. ICT Maturity Scores in Four Main Components at Each Site

Variations can be observed when looking at the ICT Maturity Scores by province (see Figure 4). On average, the ICT maturity score for District Health Office levels was 2.60. Banten Province has the best overall score (3.00), followed by East Java (2.85), DKI Jakarta (2.75), and West Nusa Tenggara (2.75). At the public health center level, the average score was 2.69, with the highest average score in Jakarta (3.18), followed by West Nusa Tenggara (2.93) and East Java (2.83). The average ICT maturity scores for the primary care clinics level were 2.87 for human resource capability and system management, 2.87 for software and information systems, 2.90 for hardware, and 3.11 for infrastructure. The DKI Jakarta Province has the highest average scores in for maturity level at primary care clinic (3.30), followed by Banten (3.10) and Aceh (3.05).

A

Province	Number of DHO	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	5 City/Districts	2,83	2,48	2,50	3,10	2,75
West Java	6 City/Districts	2,53	2,63	2,63	3,11	2,67
Banten	2 City/Districts	2,84	2,69	3,25	3,42	3,00
Aceh	11 City/Districts	2,52	2,86	2,20	2,55	2,57
East Java	9 City/Districts	2,82	3,06	2,58	2,80	2,85
West Nusa Tenggara	13 City/Districts	2,65	2,85	2,65	2,88	2,75
East Kalimantan	9 City/Districts	2,36	2,78	2,03	2,57	2,47
Center Sulawesi	8 City/Districts	2,07	2,53	2,04	2,19	2,20
Maluku	4 City/Districts	2,19	2,63	1,67	2,06	2,13
Average Score		2,53	2,72	2,39	2,74	2,60

B

Province	Number of PHC (Puskesmas)	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	6 Puskesmas	3,63	3,54	3,33	3,46	3,18
West Java	13 Puskesmas	2,67	2,93	2,65	2,67	2,61
Banten	5 Puskesmas	2,58	3,20	2,50	2,33	2,59
Aceh	27 Puskesmas	2,65	2,89	2,42	2,73	2,71
East Java	15 Puskesmas	2,93	2,83	2,57	2,84	2,83
West Nusa Tenggara	27 Puskesmas	2,96	2,94	2,84	2,92	2,93
East Kalimantan	15 Puskesmas	2,52	2,81	2,49	2,60	2,61
Center Sulawesi	11 Puskesmas	2,19	2,63	1,83	2,50	2,39
Maluku	12 Puskesmas	2,42	2,27	1,67	2,06	2,36
Average Score		2,73	2,89	2,48	2,68	2,69

C

Province	Number of Primary Care Clinic	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	1 Clinic	2,83	3,38	4,5	3,33	3,30
West Java	5 Clinics	2,87	3,00	3,25	3,03	2,99
Banten	1 Clinic	3,17	3,00	2,75	3,33	3,10
Aceh	9 Clinics	3,19	2,81	2,97	3,22	3,05
East Java	13 Clinics	2,50	2,57	2,15	2,84	2,55
West Nusa Tenggara	9 Clinics	2,41	2,59	2,42	2,81	2,54
East Kalimantan	6 Clinics	2,60	2,88	2,61	3,00	2,76
Center Sulawesi	2 Clinics	3,18	2,93	2,33	3,17	3,02
Maluku	5 Clinics	3,05	2,71	3,13	3,23	3,04
Average Score		2,87	2,87	2,90	3,11	2,93

Figure 4. Average Scores for ICT Maturity Level at the (A) District Health Offices ; (B) Public Health Centers; and (C) at Primary Care Clinic

Our analysis reveals that the Public Health Centers, Primary Care Clinics, and District Health Offices exhibit varying degrees of maturity across provinces (see Figure 5). Important findings include the human resource scores, where Aceh, Banten, and Sulawesi have better developed human resource capacities, with ratings exceeding three. Nine provinces have scores that range from two to three when it comes to software and system maturity; the only exceptions were the Public Health Centers and Primary Care Clinics in DKI Jakarta, which had scores of 3.54 and 3.38 respectively. In terms of hardware maturity level, the majority of regions score between two and three, although some have significantly lower scores than others, such as the Maluku District Health Office (1.67) and Puskesmas in Central Sulawesi (1.83). Primary Care Clinics typically show greater maturity in terms of infrastructure, with an average score of three or above. However, Maluku Public Health Center receives a score of 2.06, whereas the District Health Offices in Maluku and Central Sulawesi receive a lower score, ranging around 2.

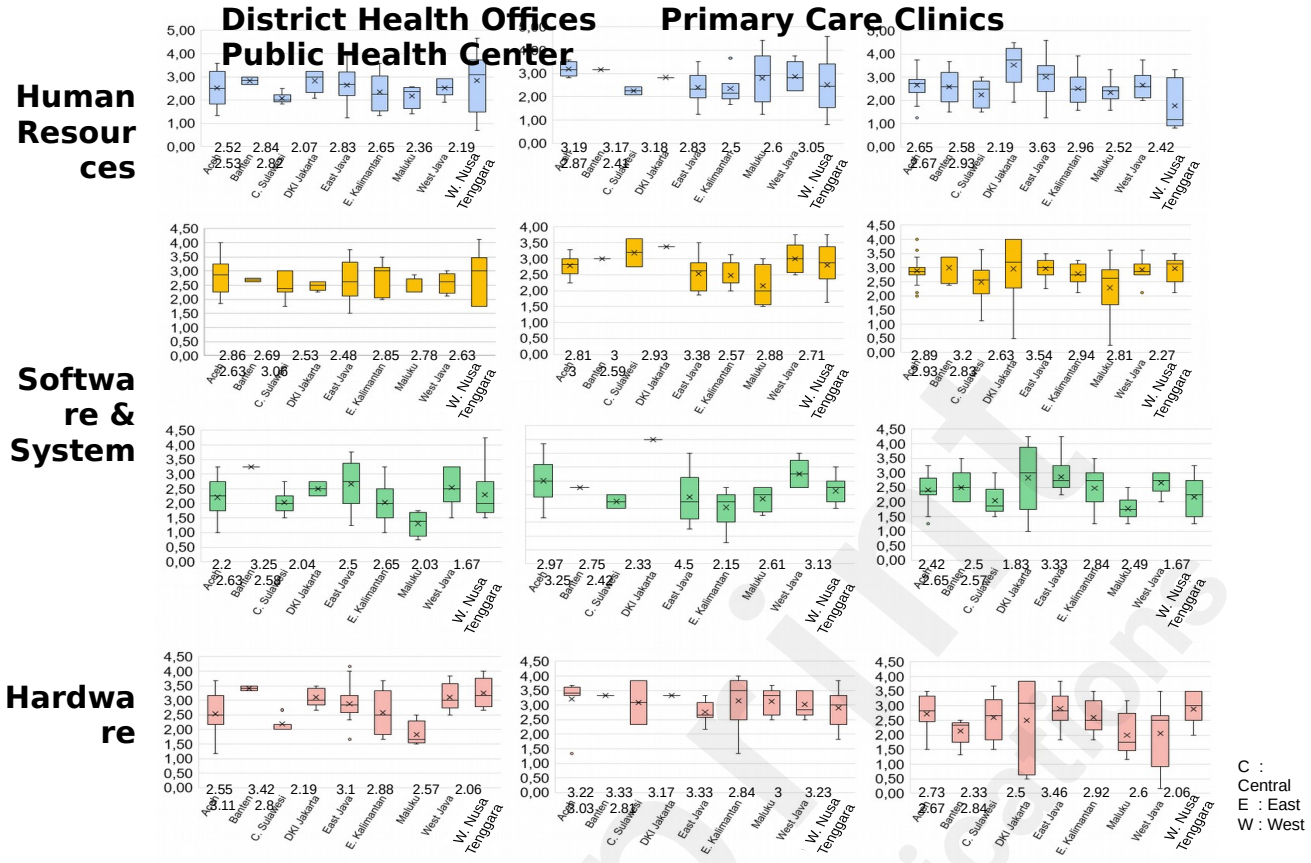

Figure 5. ICT Maturity Assessment Score Ranges Across Various Provinces and Healthcare Levels

When we examine the differences in ICT maturity based on the location of public health centers, the distribution can be observed as follows. Figure 6 shows a detailed scatter plot graph created with the ICT maturity assessment scores, which indicates differential maturity level across urban/remote locations. In terms of human resources, it is apparent that isolated locations have lower maturity scores than equivalent urban sites, although urban and rural areas have different variances. In addition, there are significant differences in the software maturity scores between rural and urban areas. The software quality in rural areas varies with maturity, whereas in urban areas it is constantly greater. On the other hand, software maturity varies in remote places.

The lower scores of the software system indicate that the facility's questionnaire responses reflect qualities that hinder digital transformation or digital maturity. Key issues identified include the absence of trained or specialized personnel for data input and information technology. Additionally, there is an excessive number of applications or information systems mandated by central or local governments. Despite the abundance of applications, not all are used effectively, and many lack interoperability, resulting in data duplication and increased workloads for health workers. Hardware components are scored based on several factors, including the reliance on manual, paper-based

methods or offline Excel tables for data input, the insufficient number of personal computers available for healthcare services and data input, the type of data storage used, such as offline or cloud-based to minimize data loss, and the quality and stability of the data server. For infrastructure, the scores for some regions are lower due to the poor internet quality available in health facilities and the inconsistent power availability, which is not guaranteed 24 hours a day. In some cases, power outages can occur even during operational hours.

Regional differences in hardware quality were also evident, with varying degrees of quality found in rural, urban, and remote locations. While remote areas have challenges due to lesser quality or limits, rural and urban areas generally have higher standards for hardware quality. The trends seen in hardware and infrastructure are strikingly comparable, highlighting a shared tendency between these elements. These findings offer important insights into the particular opportunities and problems faced in various situations, as well as an intricate picture of ICT maturity across various geographies. These findings highlight specific area characteristics which may aid the government decide appropriate approaches for ensuring the effective implementation of digital health services in these areas.

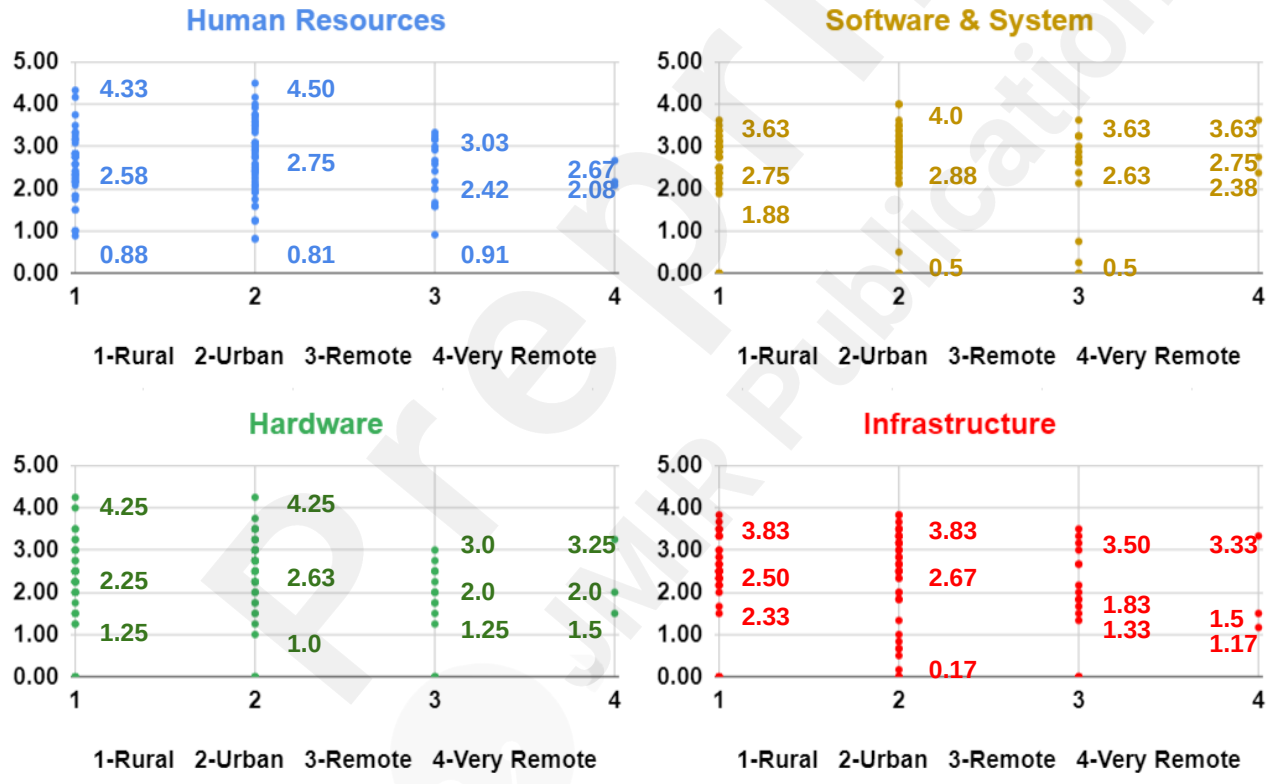

Figure 6. ICT Maturity Scores Scatter Plot by Main Components and Site Locations

In addition to assessing digital maturity through scoring, we conducted a Focus Group Discussion, the findings of which highlighted a number of staffing and human resources-related issues. Firstly, there were people in the healthcare facilities and district health offices with a variety of backgrounds, but not all of them IT literate. Secondly, data input was typically done by health officials or health workers; these staff members lack professional IT certification or training. Thirdly, the duty of data analysis was usually performed by nurses and staff at health centers due to a shortage of

professionals with the necessary capabilities. Fourthly, a large number of different unintegrated health information systems add to the burden of data reporting. Lastly, a further obstacle was the lack of hiring civil servants to fill the paucity of IT professionals with computer knowledge.

In terms of software and information systems, issues included frequent system disruptions, poor system performance, and operational difficulties. The largest issue with software was the sheer number of health information systems that required data input but were not interoperable. For instance, a question about immunization status appeared in two existing systems: the system for tracking toddlers' nutritional status and in the immunization system. Because there was no data integration in place, healthcare personnel were forced to continually enter the same data into multiple systems as a result of this redundancy.

The complexity was further increased by the ongoing addition of new applications from numerous sources, such as the Ministry of Health, other governmental organizations, or municipal governments. These applications frequently demand a lot of data entry, which makes data management quite difficult. Furthermore, the prevalence of paper-based reporting techniques persists even in the face of digital alternatives. These difficulties highlight the need for more efficient and integrated solutions in the healthcare industry by impeding the overall simplification of data entry and system operations.

Numerous hardware-related issues emerged during the FGD. Program managers frequently had to use their own laptops because their Public Health Centers don't have enough resources. Despite the fact that the office has multiple computers, they were for shared usage and in some subdistricts, the computers were limited and used only for the registration and administrative sections. In others, there were only two up to five computers available to fulfill the management requirements of the entire public health center. Staff members occasionally use their personal laptops for data reporting. Furthermore there were service recording delays due to PC storage limits. In addition, operational difficulties were exacerbated when individuals’ PCs experienced slowness or malfunctions, and when data storage was not centralized but rather restricted to individual PCs without cloud backup.

Regarding infrastructure, the intermittently weak signal on Wi-Fi and internet-connected devices in several places was mentioned. The employees routinely utilize Wi-Fi, but they frequently run into network issues. Consequently, all reporting needed to be completed manually in certain locations or using personal mobile data or paper based data collection. Moreover, server outages occasionally caused delays or even entirely stopped the data recording process. Additionally, there was no dedicated data storage, thus data is at risk during sporadic power outages, which are particularly problematic in situations such as wildfires.

Discussion

The analysis of ICT maturity in Indonesia healthcare providers reveals an overall average score of 2.74, indicating maturity between basic and good levels, aligned with the ICT maturity level pyramid. Variations exist across provinces and healthcare levels, with Banten Province exhibiting the highest overall score. DKI Jakarta Province stands out with superior scores at the public health center level and primary care clinic maturity. Disparities in human resource, software, hardware, and infrastructure maturity exist between provinces and healthcare levels, with rural areas generally lagging behind urban areas. These findings underscore the importance of tailored strategies to address regional disparities and enhance digital health service implementation effectively.
The ICT maturity level has the potential to affect the quality of national health services, with the

highest impact being felt in developing countries. Excellent ICT maturity can lead to a good digital health implementation and potentially contribute to the improvement of healthcare aspects, such as quality of care, supplies and logistics, training and communication, community engagement and participation in health services, and the availability and use of routine data by decision-makers. [11,12,13] The current research provides a snapshot for the ICT maturity in several healthcare services across Indonesia and explores factors that would require further attention.

The results of the questionnaires show the variety of ICT maturity among provinces, districts, and health facilities, with variations in critical components such as human resource capabilities, software and information systems, hardware, and infrastructure. These disparities not only indicate the different provinces' ICT readiness but also highlight potential areas for improvement and development to enhance healthcare service delivery and information management in each respective region. Understanding these variations is crucial for devising targeted strategies to address specific ICT-related challenges and opportunities within the healthcare system across diverse geographical locations.

The development of ICT in Indonesia is facing tough challenges due to its geography, consisting of thousands of islands and many cultures that affect the education, social, and economical aspects. Moreover, Indonesia as an archipelago has many remote areas where the telecommunication and internet services providers cannot develop the sufficient infrastructure as such these areas are unavoidably under-represented.[13-15] Indonesia ranked 111 on the 2017 ICT Development Index, falling behind fellow Southeast Asia Countries: Singapore (18), Brunei Darussalam (53), Malaysia (63), Thailand (78), and Philippines (101).[16]

Regarding human resources, often staff members do not have adequate digital literacy, and yet are assigned to reporting using IT processes, as is indicated by our work as well.[17,18] Moreover, there is a shortage of staff with computer expertise and insufficient data management training opportunities on offer to mitigate this issue. The same is described in Malaysia, where challenges related to human resources include workload, readiness, skills, and user dependency. Additionally, tasks often require health workers to focus on mining data, instead of improving service provision. [19-22]

Indonesia also faces a mindshift challenge for staff, as the plurality of overlapping systems comes against a context of well-established manual data collection, using paper or status books. By contrast, frequent input of overlapping variables across multiple software, adds to the work burden of individual healthcare staff, and makes the digital health process inefficient. Countries in sub-Saharan Africa, also faced a similar challenge: they documented 738 distinct digital health interventions at different levels of functioning in the SSA region over the past 10 years. One in five of those did not have a link to any health service outcomes, and only half could be classified as “established” at the end of the study period. Two of every three were focused solely on solutions in one healthcare activity, limiting integration.[19] This aspect has not been researched as yet for the countries neighboring Indonesia.

The existence of infrastructure remains the main challenge in developing and implementing e-government in developing countries.[23,24] In the healthcare industry, the continuity of using information and communication technology on daily and routine operations depends on the availability of robust IT infrastructure. Unfortunately, many developing countries lack the necessary infrastructure to support digital health, specifically telecommunication and electricity networks coverage.[24,25,26] This is also supported by other studies that found the IT systems used in the healthcare industry will be optimal, effective, and efficient when adequate facilities and infrastructure support them.[27-30]

The discrepancies in infrastructure availability across the provinces in Indonesia directly affect a

stable internet connection. Frequent internet signal downtime, network problems, poor connection, and insufficient computer availability, including the lack of electricity supplies in some remote areas, were found in this study, showing the need for further improvements in technology infrastructure and facilities. This lack of and instability of IT infrastructure, such as the limitation of internet access, electricity supply, and availability of computers is common across LMICs, as similar findings were described for Brazil, Sub-Saharan Africa as a whole, Sierra Leone, and Tanzania.[31-35]

These findings are crucial to have better understanding to support Indonesian Health Technology Transformation mentioned in the Blueprint of Health Transformation Strategy 2024. The foundation to transform the health systems is by having a solid platform architecture design and infrastructure to implement integrated and interoperable health systems. The blueprint highlighted the plan of integrating all EMR systems from public health centers, hospitals, primary care clinics, laboratories into the Satu Sehat platform and adopting Satu Sehat standard. This study showed that to support the implementation of digital health transformation, the government should identify the gap, map the area based on capacity, and provide assistance to improve the software, hardware, infrastructure and human resource capacity especially in areas with lower ICT maturity scores.

Strength and Limitations

The strengths of the study involve exploring ICT maturity in Indonesia engaging several healthcare service sites, i.e., Puskesmas, clinics, and health departments. Furthermore, the results of the FGD provide a more detailed overview of the challenges related to the four assessed components, thus highlighting areas for future improvements to support the ongoing healthcare digital transformation.

The limitations of the study are: (1) the involvement of Public Health Center and Primary Clinic in the study was limited in each province and perhaps is not entirely representative, although health departments involved in the study represented 80-90% of the nine targeted provinces and districts; (2) other healthcare facilities, such as hospitals, laboratories, and pharmacies, were not involved in this study, as such additional aspects of needs/challenges may exist that have not been highlighted as yet. This may have implications for the representativeness of healthcare data users by volume; (3) the representativeness based on infrastructure distribution and regional characteristics (urban, rural, remote, and very remote) should be viewed only as indicative, as healthcare services from more remote rural regions are less likely to have access to stable internet connection, and thus able to complete such a questionnaire distributed by digital channels; and (4) the respondents' capacity can influence data completeness, thus it would be useful for future iterations if staff representing more functions of the healthcare centers are able to complete the questionnaire.

Conclusions

This study investigates for the first time the variations of ICT maturity level across healthcare (Public Health Centers, Primary Clinics, and District Health Offices) in nine provinces in Indonesia, underscoring the diversity in ICT implementation and readiness. The maturity of ICT utilization is influenced by several critical components, specifically enhancing human resources, ensuring infrastructure and the availability of supportive hardware, and optimizing information systems. The findings of this study are in line with similar studies in developing countries elsewhere in the world. Our results demonstrate that to attain ICT maturity in healthcare services in Indonesia, it is imperative to address all of the above aspects, as all represent ongoing needs and are shown to be equally as important and needed in the field.

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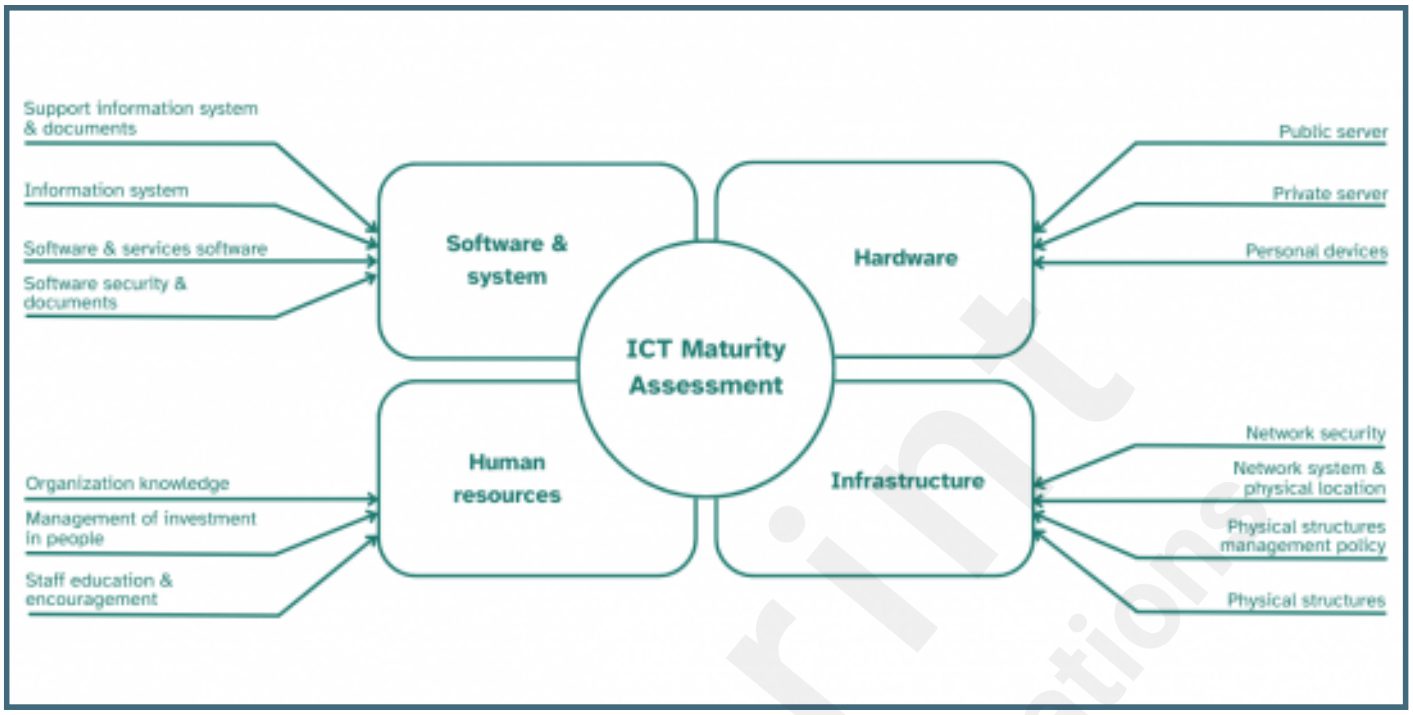
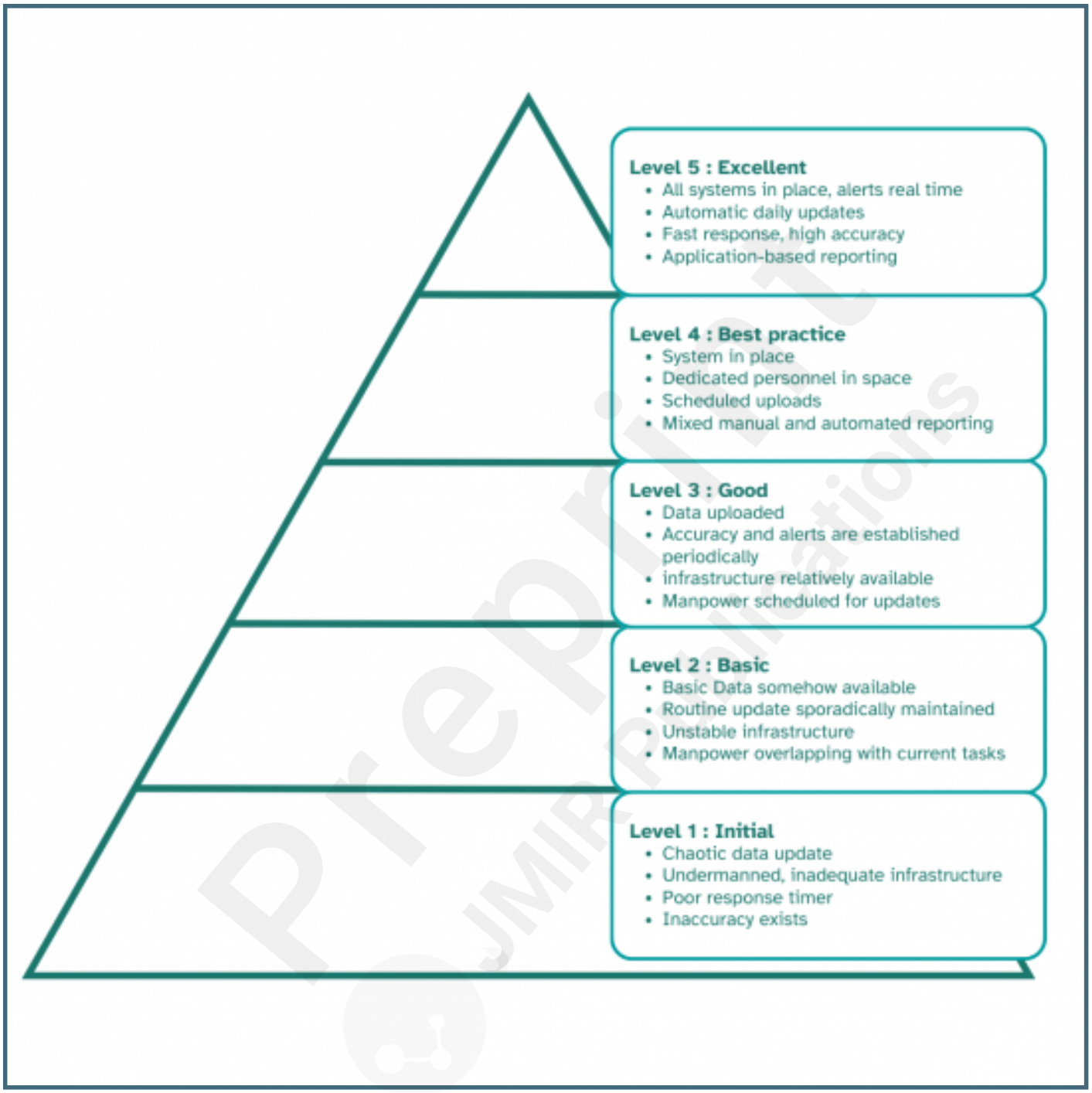
Supplementary Files

Figures

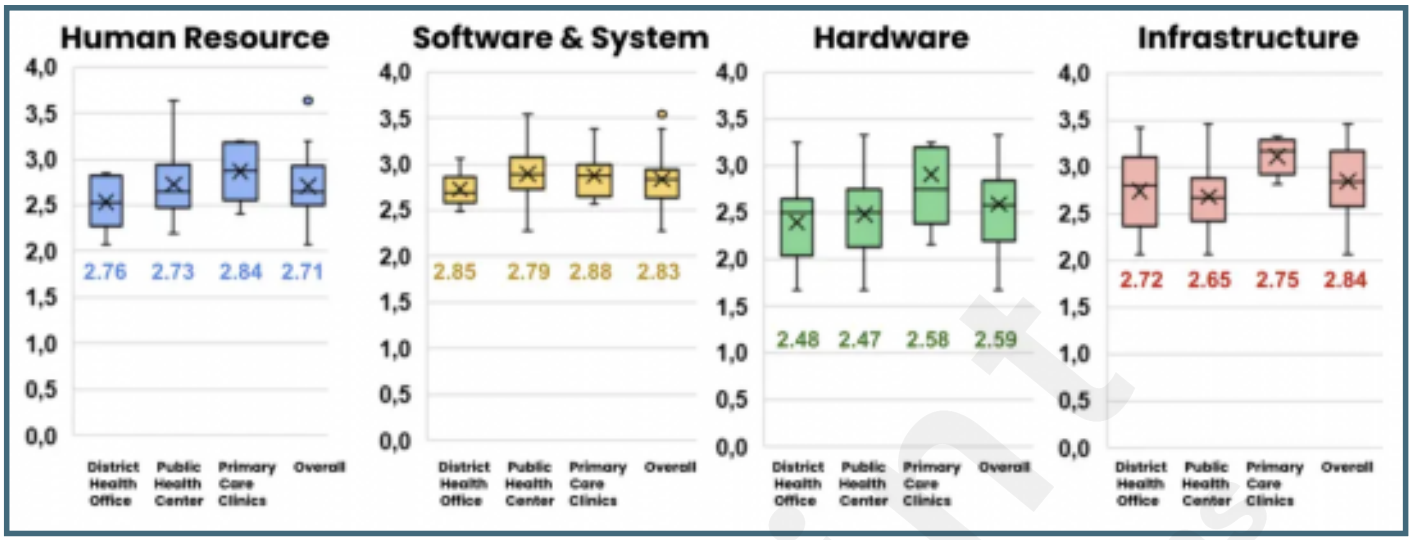
The components evaluated in the ICT Maturity Assessment.



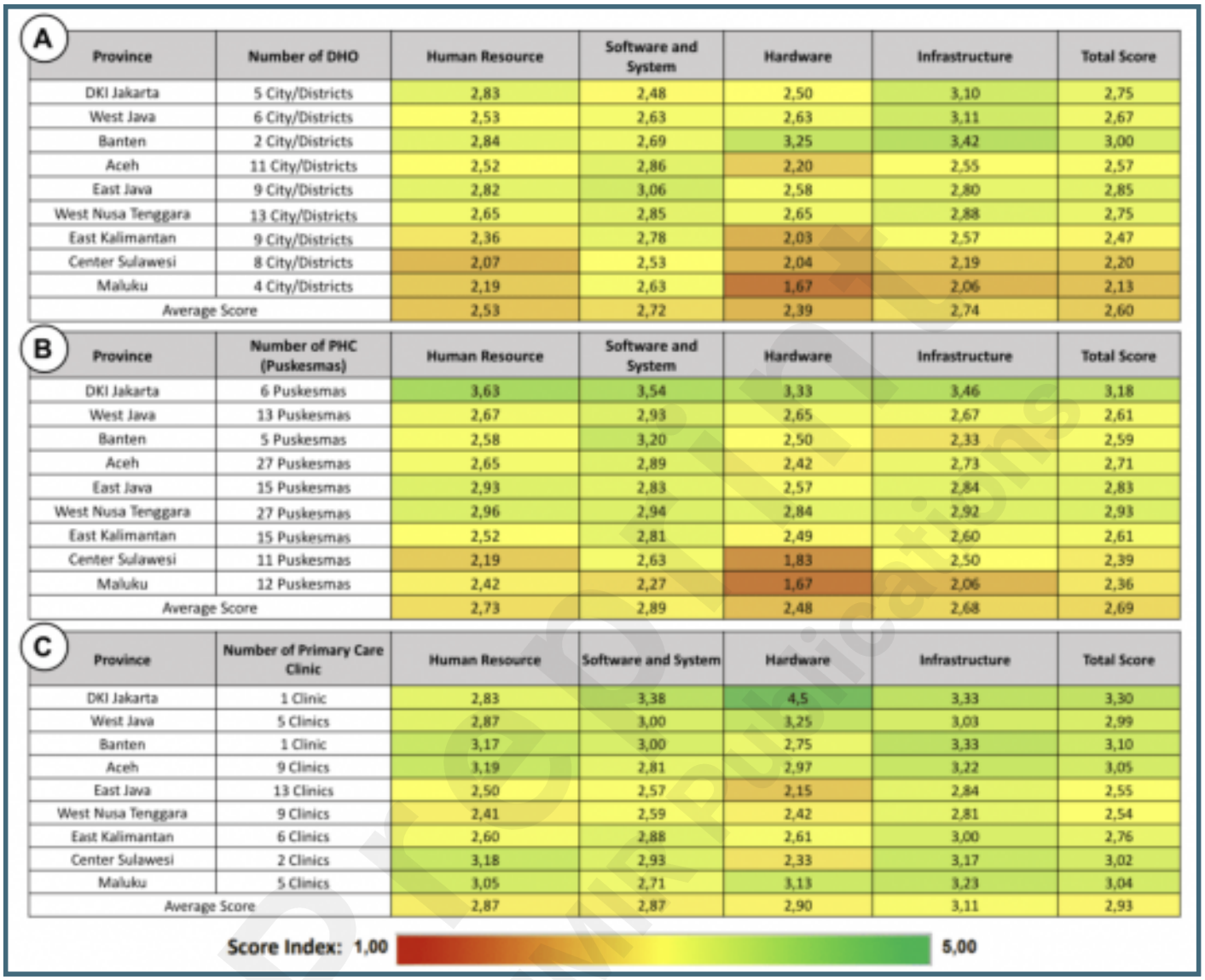
ICT Maturity Level.



ICT Maturity Scores in Four Main Components at Each Site.



Average Scores for ICT Maturity Level at the (A) District Health Offices; (B) Public Health Centers; and (C) at Primary Care Clinic.



A

Province	Number of DHO	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	5 City/Districts	2,83	2,48	2,50	3,10	2,75
West Java	6 City/Districts	2,53	2,63	2,63	3,11	2,67
Banten	2 City/Districts	2,84	2,69	3,25	3,42	3,00
Aceh	11 City/Districts	2,52	2,86	2,20	2,55	2,57
East Java	9 City/Districts	2,82	3,06	2,58	2,80	2,85
West Nusa Tenggara	13 City/Districts	2,65	2,85	2,65	2,88	2,75
East Kalimantan	9 City/Districts	2,36	2,78	2,03	2,57	2,47
Center Sulawesi	8 City/Districts	2,07	2,53	2,04	2,19	2,20
Maluku	4 City/Districts	2,19	2,63	1,67	2,06	2,13
Average Score		2,53	2,72	2,39	2,74	2,60

B

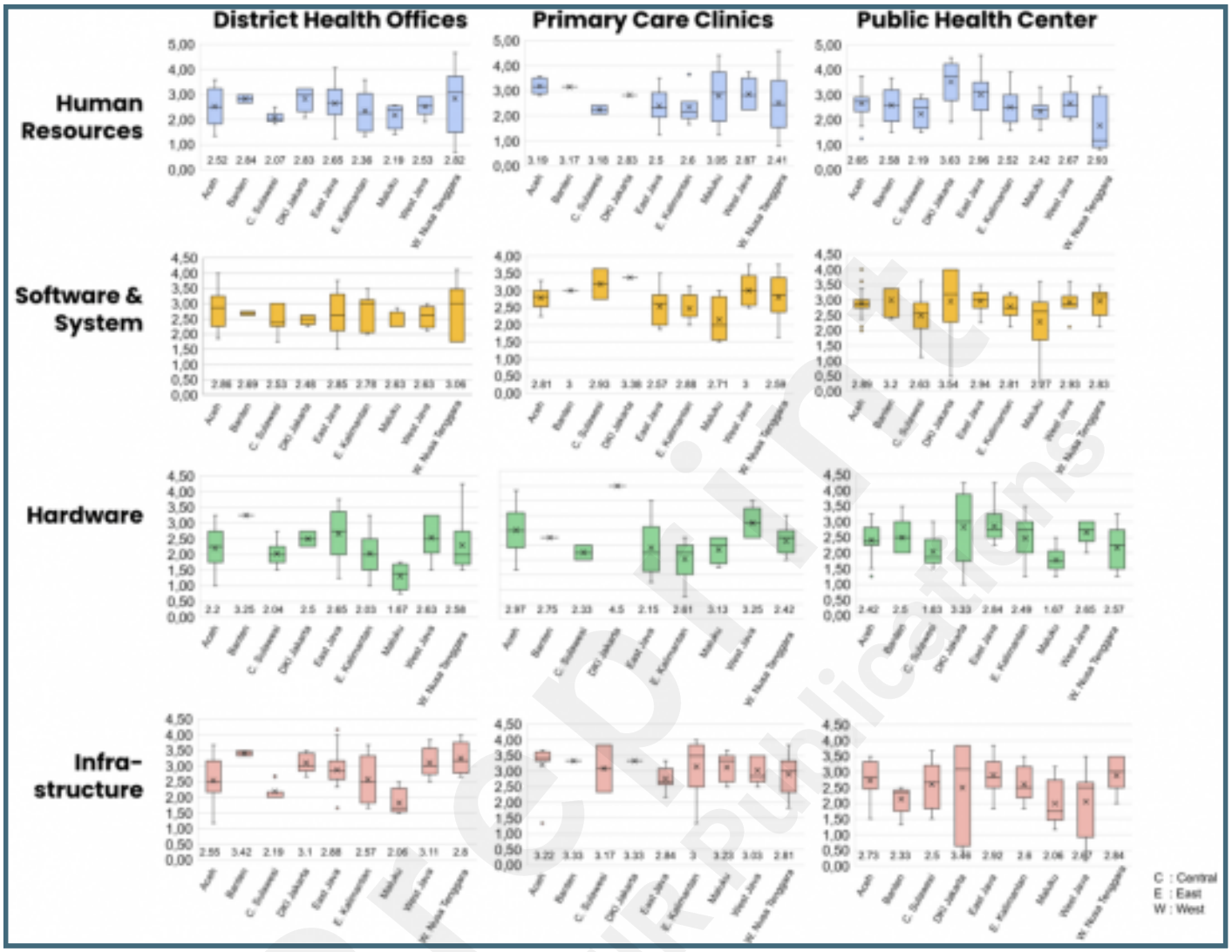
Province	Number of PHC (Puskesmas)	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	6 Puskesmas	3,63	3,54	3,33	3,46	3,18
West Java	13 Puskesmas	2,67	2,93	2,65	2,67	2,61
Banten	5 Puskesmas	2,58	3,20	2,50	2,33	2,59
Aceh	27 Puskesmas	2,65	2,89	2,42	2,73	2,71
East Java	15 Puskesmas	2,93	2,83	2,57	2,84	2,83
West Nusa Tenggara	27 Puskesmas	2,96	2,94	2,84	2,92	2,93
East Kalimantan	15 Puskesmas	2,52	2,81	2,49	2,60	2,61
Center Sulawesi	11 Puskesmas	2,19	2,63	1,83	2,50	2,39
Maluku	12 Puskesmas	2,42	2,27	1,67	2,06	2,36
Average Score		2,73	2,89	2,48	2,68	2,69

C

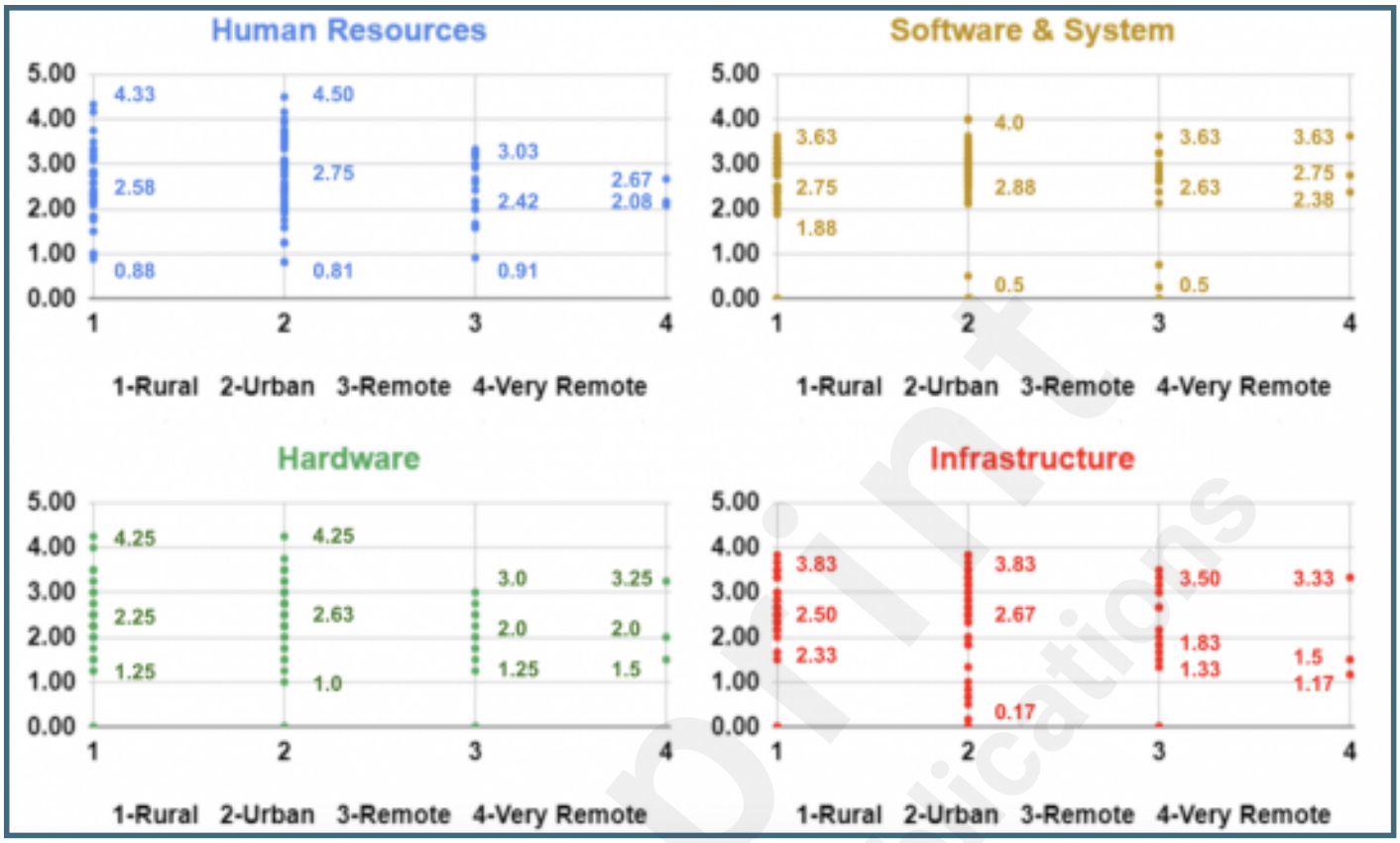
Province	Number of Primary Care Clinic	Human Resource	Software and System	Hardware	Infrastructure	Total Score
DKI Jakarta	1 Clinic	2,83	3,38	4,5	3,33	3,30
West Java	5 Clinics	2,87	3,00	3,25	3,03	2,99
Banten	1 Clinic	3,17	3,00	2,75	3,33	3,10
Aceh	9 Clinics	3,19	2,81	2,97	3,22	3,05
East Java	13 Clinics	2,50	2,57	2,15	2,84	2,55
West Nusa Tenggara	9 Clinics	2,41	2,59	2,42	2,81	2,54
East Kalimantan	6 Clinics	2,60	2,88	2,61	3,00	2,76
Center Sulawesi	2 Clinics	3,18	2,93	2,33	3,17	3,02
Maluku	5 Clinics	3,05	2,71	3,13	3,23	3,04
Average Score		2,87	2,87	2,90	3,11	2,93

Score Index: 1,00 5,00

ICT Maturity Assessment Score Ranges Across Various Provinces and Healthcare Levels.



ICT Maturity Scores Scatter Plot by Main Components and Site Locations.



Multimedia Appendixes

Questionnaire.
URL: http://asset.jmir.pub/assets/4bf916677eb97da3b450b0bd696df96e.docx

Questionnaire difference.
URL: http://asset.jmir.pub/assets/870429c117eacb981925c1fd7508c4e5.docx