JURNAL TEKNIK SIPIL DAN LINGKUNGAN|EISSN:2549-1407
https://jurnal.ipb.ac.id/index.php/jsil

Vol. 10 No. 02 October 2025
DOI: 10.29244/jsil.10.2.213-224

# Analysis of Smart Infrastructure Implementation in Facilities and Infrastructure of Supporting Hospital for Nusantara Capital City

**Rahmad and Oryza Lhara Sari***

Civil Engineering Study Program, Department of Civil Engineering and Planning, Kalimantan Institute of Technology, Balikpapan, 76127 Indonesia
*corresponding author: oryza@lecturer.itk.ac.id

**Submitted** : 02 Sep 2024
**Revised:** 14 Oct 2024
**Accepted** : 04 Nov 2024

**Abstract:** As part of the 100 Smart Cities program and a buffer for the Nusantara Capital City (IKN), Balikpapan City is facing a population growth that has the potential to increase. This growth affects the quality of health services at Hospital X in Balikpapan City, where physical and digital infrastructure needs to be improved to accommodate the needs of patients and visitors. Infrastructure challenges include improving waste management facilities and infrastructure that are still inadequate in line with the increase in patients, as well as the lack of facilities for people with disabilities throughout the hospital area. Therefore, the purpose of this study is to analyze the application of the smart infrastructure concept based on the priority level of variables between mobility, energy management, networks and telecommunications, waste and waste management, and health variables, so that it is expected to provide quality from the existing physical and digital infrastructure to staff workers, patients, and hospital visitors. The results of the analysis using the Analytical Hierarchy Process method obtained a priority scale based on the weight value obtained is Mobility (0.252) with the implementation of a smart parking system (0.208), Energy Management (0.208) with the implementation of smart renewable energy (0.354), Waste and Waste Management (0.197) with the implementation of smart waste bins (0.353), Network and Telecommunication (0.195) with the implementation of automatic attendance using fingerprints (0.369), and Health (0.149) with the implementation of medical sensors to monitor chronic disease patients (0.237).

**Keywords:** *Analytical Hierarchy Process* (AHP), smart infrastructure, hospital

## 1. Introduction

Balikpapan City is one of 100 cities implementing the smart city concept in Indonesia. Smart city development covers various fields, including economics, social, infrastructure and health [1 , 2] . In an academic context, smart cities are divided into two domains: the soft domain, which includes education, culture, policy innovation, social and governance, and the hard domain, which includes infrastructure such as buildings, energy networks, and water and waste management as well as mobility and logistics [3].

Smart city concept in Indonesia, including in Balikpapan City, still faces many obstacles, such as inadequate infrastructure, local government readiness, and lack of digital technology innovation [4]. This was added by the chairman of the Bapemperda DPRD of Balikpapan City, Arif Agung, stating that as a buffer for Nusantara Capital City (IKN), Balikpapan must overcome various infrastructure problems, including housing availability, pollution, clean water demand, flood risk, waste management, transportation, traffic jams, as well as issues of local labor employment and population growth.

The concept of smart city can be identified through four characteristics, namely industry, education, participation, and technical infrastructure, which are then expanded into six components in the implementation of smart city, namely smart people, smart living, smart economy, smart mobility, smart environment, and smart governance [5]. International Business Machines Corporation (IBM) stated that smart city design aims to make cities empowered, sustainable and livable, with six main research indicators covering society, area, economy, smart living, accessibility and infrastructure [6].

Infrastructure which is the main part of a city will certainly be one of the indicators of the implementation of the smart city concept. In the smart city concept, infrastructure can be developed into a smart infrastructure concept with smart implementation that utilizes real-time information and integrated integration in urban areas to create efficient and environmentally friendly multimodal transportation access and includes the integrity of all information and activities in real time using effective technology and supporting sustainable life [7]. The smart infrastructure concept itself is divided into two parts, namely physical smart infrastructure and digital smart infrastructure. Physical smart infrastructure is a physical infrastructure with six components that include smart buildings, smart mobility and transport, smart energy/grid, smart water management, smart waste management , and smart healthcare [8]. While smart digital infrastructure is a digital infrastructure that optimally utilizes all connected information using information and communication technology (ICT), smart digital infrastructure consists of seven digital support layers including urban layer, sensor layer, data analysis layer, connectivity layer, automations layer, broadband connectivity, the internet of things , and big data [8].

The development of smart infrastructure carried out in Bandar Lampung City shows that the implementation of urban smart infrastructure includes six variables, namely clean water, waste water, drainage, waste, electricity, and telecommunications. The urban infrastructure variables in Bandar Lampung City are still mostly in the early stages, while clean water and telecommunications networks are more advanced, and electricity is at a more sophisticated stage, showing progress towards the concept of smart infrastructure in Bandar Lampung City [10]. The success of implementing smart infrastructure can be applied in various city infrastructures, one of which is the University, the results obtained show that the implementation of smart infrastructure has an effect of 70.9% on improving employee performance in higher education [11] .

Hospitals as one of the city's infrastructures are now slowly shifting to the application of smart hospital and smart infrastructure technology, which requires digitalization and management to improve safety, operational efficiency, and patient service [12]. Hospital staff often face heavy workloads and labor shortages, which leads to fragmentation in tasks and decreased quality of service [13]. The implementation of the smart hospital concept integrates technology and data to improve health outcomes and user satisfaction, and transforms from physician-centered care to patient-centered care [14, 15]. Thus, information technology is very important in optimizing patient-focused services.

Based on the document of the Strategic Plan for Change (Renstra-P) 2019-2023 at Hospital X in Balikpapan City, the infrastructure conditions in Balikpapan can affect the performance of the hospital, the SWOT analysis contained in the document shows several weaknesses that need to be improved at Hospital X in Balikpapan City, including the quality of service facilities that need to be improved, the customer satisfaction index that has not met the target, the shortage of sub-specialist doctors and nurses, and problems with the doctor's visit schedule and the search for medical record documents which are still manual. The profile document of Hospital X in Balikpapan City in 2021 also notes several shortcomings such as human resources and infrastructure that need to be improved, including medical apparatus for sub-specialist doctors and facilities for people with disabilities.

In realizing a smart city, there needs to be an improvement in one of the areas which is infrastructure, infrastructure development can be carried out with the concept of smart infrastructure which is expected to provide feasibility of facilities by considering the efficiency of the use of the infrastructure. In addition, the application of the smart infrastructure concept is carried out to adjust the current situation and conditions where each construction of a building pays attention to the manifestation of a more efficient and sustainable environment. Analysis of the application of smart infrastructure located at Hospital X, Balikpapan City aims to provide improvements to existing or non-existent services with the concept of smart infrastructure. The application of smart infrastructure concept is obtained from the results of the analysis of variables that are a priority and are very much needed by users, both patients, visitors or staff at Hospital X, Balikpapan City.

## 2. Method

### *2.1. Material*

The research conducted at Hospital X in Balikpapan City used equipment consisting of hardware, software, and materials in the form of secondary and primary data. The hardware is a laptop equipped with softwares which are Microsoft Excel, Expert Choice, and IBM SPSS Statistics. As for the collection of primary and secondary data, primary data was obtained from distributing physical and digital questionnaires; and interviews with the hospital, while secondary data was obtained from documents related to Hospital X in Balikpapan City which included the number of staff, hospital visits and the condition of the existing infrastructure.

### *2.2. Research Procedures*

The research process was carried out as follows: problem identification, literature studies to determine smart infrastructure variables, collection of primary and secondary data, preliminary survey analysis, pilot survey, and analysis of questionnaire results to determine priority variables in the implementation of smart infrastructure.

#### *2.2.1. Number of Samples Determination*

The population in this study already exists so that the sampling technique is carried out by taking non-probability samples (nonprobability sampling) purposive sampling type. Purposive sampling as a sample assessment, selective or subjective with a sampling technique based on the total population. In determining the number of samples, the greater the number of samples, the smaller the error in taking the number of samples [17] . **Equation (2)** for the statistic formula used in determining the number of samples is the Slovin formula.

$$n = \frac{N}{1 + Ne^2} \quad (2)$$

With :

n = Number of samples

N = Population Size

e = Maximum percentage error

The error tolerance limits used are as follows:

1. The value of e = 0.1 (10%) for a large population
2. The value of e = 0.2 (20%) for a small population.

Distinguish populations based on the number of population members where:

1. A small population with less than 500 members
2. A large population with more than 150,000 members

Employees or staff workers at Hospital X in Balikpapan City based on data on December 31, 2021 as many as 1,286 and in 2024 based on the official website of Hospital X in Balikpapan City as many as 1,806 people consisting of medical personnel, paramedics, medical support, and other personnel. For visitors consisting of visitors, outpatients, inpatients, and emergency care as many as 130,158 people, based on this data, interpolation was carried out to obtain the percentage of error tolerance from the number of population owned. The linear interpolation formula used is **Equation (3)** :

$$f(x) = f(x0) + \frac{f(x1) - f(x0)}{(xa - x0)}(x - x0) \tag{3}$$

With :

| | |
|---|---|
| $f\,(x)$ | = percentage of the value sought |
| $f\,(x0)$ | = percentage error of small population value |
| $f\,(x1)$ | = percentage error of the value of the large population |
| $x$ | = the population value sought |
| $x\,0$ | = small population value |
| $x\,1$ | = value of large population |

*2.2.2. Preliminary Survey Analysis*

The preliminary survey was conducted by distributing questionnaires to experts or practitioners with the aim of evaluating the relevance of the variables and sub-variables that had been determined. The number of experts is at least three people who are experienced and understand the research topic [16], the three people can come from three different professional fields, namely academics, business, and governments. In this study, experts with professions in the academic field are lecturers, experts with professions in the business field are practitioners who work at Hospital X, Balikpapan City, and experts with professions in the government field are practitioners who work in the Balikpapan government. The results of the expert assessment were then processed by means of a mean test and calculation of the cut-off value to determine the relevant sub-variables then became a list of questions on the questionnaire, irrelevant sub-variables will be deleted. The preliminary survey was conducted by distributing questionnaires with an open questionnaire type, namely experts can provide additional notes. The *cut-off value f* can be calculated using **Equation (1)**

$$cut\ offvalue = \frac{Maximum\ mean\ value + Minimum\ mean\ value}{2} \tag{1}$$

*2.2.3. Pilot Survey Analysis*

*The pilot survey* was conducted to evaluate the reliability and validity of the measurement scale to be used. The main purpose of the pilot survey is to test how effective the survey indicators (questionnaires) are as a communication tool between researchers and respondents. *T*he pilot survey involved distributing the initial questionnaire to 10% of the total sample used. In this study, if there were statements that were not understood by the respondents in the pilot survey results, then the wording of the statement would be corrected. However, if all statements could be understood well by the respondents, the study could be continued with the distribution of the main questionnaire.

*2.2.4. Questionnaire Data Analysis*

After the questionnaire was distributed, the questionnaire data was summarized with the following criteria:

1. Samples of staff can consist of structural workers, general functional workers and specific functional workers.
2. Sample of visitor who has been a patient or who has visited Hospital X in Balikpapan City.

3. Sample of visitor who visited Hospital X, Balikpapan City at least two times.
4. The age range of the sample who fill-out the questionnaire was 17-65 years old.

Furthermore, to strengthen the validity of the questionnaire data, data analysis was carried out, namely validity and reliability tests with the help of IBM SPSS Statistics software, then to determine the main priority values in the application of smart infrastructure using the Analytical Hierarchy Process method. AHP analysis was carried out to ensure compliance with research needs. If the data is not appropriate or inconsistent, with a consistency ratio less than desired (0.1), then the distribution of questionnaires will continue until the data needed for the study becomes valid and consistent. Before carrying out the analysis stages of the Analytical Hierarchy Process method, a geometric mean calculation was carried out based on the questionnaire data. Specifically, the geometric mean can be used as a middle value to calculate the average ratio, percentage, and rate of change in one period compared to another period [18]. Mathematically, the geometric mean is the n-th root of the result of multiplying n numbers. The geometric mean of N units of the data population can be calculated using the following **Equation (4)** .

$$G = \sqrt[N]{X_1 \times X_2 \times \ldots \times X_n} \quad (4)$$

With :

G = Geometric mean

N = Number of Assessments

$X_1$ = assessment 1,2,3…n

The stages used in the AHP method are as follows [19] :

a. In this study, problem identification was carried out, determining the desired solution, and then compiling a hierarchy of the problems faced. The hierarchy was determined by determining the objectives which are the overall targets of the study.
b. Determined the priority of elements by performing pairwise comparisons, that is, comparing elements with each other according to established criteria. The pairwise comparison matrix was filled with numbers to describe the relative importance of an element to another element.
c. Performing synthesis by considering the combined pairwise comparisons to obtain overall priorities. The steps taken were Performing Matrix Normalization to unify all matrix elements in the form of variables and sub-variables so that the scale values in the matrix elements could be said to be uniform. Before performing matrix normalization, a matrix table was prepared in the form of paired comparison values. Next, perform the matrix normalization calculation by dividing the comparison value by the number of comparison values that are parallel to 1 column/row, the results were then added up one row for each variable which was then divided by the number of variables. This was done to calculate the priority vector (V) value so that the weight value was obtained in determining the priority scale of each variable. The priority vector (V) value was then multiplied by the pairwise comparison value to calculate the matrix multiplication which will later be used in calculating the consistency value.
d. Measuring consistency by considering the consistency level value so that the decision obtained was not based on low consistency considerations (inconsistent). The consistency value was calculated by dividing the matrix multiplication value by the priority vector value. The average consistency value is in the form of delta max ( $\lambda_{maks}$)
e. Calculate the Consistency Index (CI) value using **Equation (5)** as follows:

$$CI = \frac{\lambda_{maks} - n}{(n-1)} \quad (5)$$

With :

n = number of elements

f. Calculate the Consistency Ratio (CR) value using **Equation (6)** as follows:

$$CR = \frac{CI}{RI} \tag{6}$$

With :
CR = *Consistency Ratio*
CI = *Consistency Index*
RI = *Random Consistency Index*
Determination of the Random Consistency Index value based on the assessment scale value (n), the RI value can be seen in **Table 1.**

**Table 1.** Random Consistency Index Values [20]

| n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

g. Checking Hierarchy Consistency
If the value exceeds 10%, the assessment data assessment must be adjusted (questionnaire redistribution). However, if the consistency ratio (CI/IR) ≤0.1, the calculation results are considered vailed

## 3. Results and Discussion

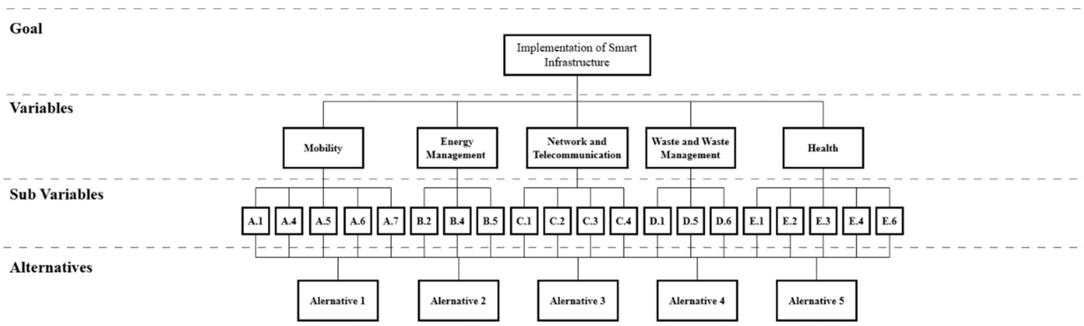
Experts who filled out the preliminary survey questionnaire met the expert criteria with three certified experts, and three experts based on their last education and work experience. The preliminary survey that had been conducted to experts who provide responses related to the relevance of sub-variables in implementing smart infrastructure, obtained the lowest average value of 3,857 and the highest average of 5, using **Equation (1),** then the cut off value is 4,417 so that the sub-variable can be said to be relevant if the value of each sub-variable is the same or more than 4,417. In addition, there are suggestions and additional variables from several experts, so in the main survey in distributing the questionnaire there were 22 sub-variables from 5 variables. The variables and sub-variables of the main questionnnnnnaire are shown in **Table 2.**

**Table 2.** Smart Infrastructure Variables and Sub-Variables

| No | Code | Variables | Sub Variables |
|---|---|---|---|
| A | A1 | Mobility | Assistance for safe driving in ambulances |
| | A4 | | Pedestrian area |
| | A5 | | Automatic Door |
| | A6 | | Smart Parking System |
| | A7 | | Children's Playroom |
| B | B2 | Energy Management | Smart meters for electricity, gas and water |
| | B4 | | Smart Renewable Energy |
| | B5 | | Heating, Ventilation, and Air Conditioning (HVAC) |
| C | C1 | Network and Telecommunication | Wi-fi Internet Network |
| | C2 | | 3G-5G internet network |
| | C3 | | Integrated service web-site publishing |
| | C4 | | Automatic attendance using fingerprint |
| D | D1 | Waste and Waste Management | Centralized temporary waste disposal |
| | D5 | | Smart Waste Bins |
| | D6 | | Smart Waste Water Treatment |

| No | Code | Variables | Sub Variables |
|---|---|---|---|
| E | E1 | Health | Floor with Emergency Support |
| | E2 | | Medical sensors monitor chronic disease patients |
| | E3 | | Health Mobile |
| | E4 | | Smart infusion pump with RFID |
| | E6 | | Electronic Medical Records |

Based on **Table 1,** the hierarchy plan image of the Analytical Hierarchy Process (AHP) method for implementing smart infrastructure can be seen in **Figure 1.**



nn

**Figure 1.** Smart Infrastructure Implementation Hierarchy

The data collection process was carried out by distributing questionnaires to research respondents consisting of visitors and staff workers at Hospital X, Balikpapan City. By using a purposive sampling technique based on the known population, the number of respondents was obtained based on **Equations (2) and (3)**, namely 110 respondents, with a sample division for visitors of 85 respondents and staff workers of 25 respondents. Percentage data for all respondent criteria with a total number of respondents of 110. Data collection was carried out by distributing questionnaires online and offline. The online distribution media was carried out using Google Form, which was then the Google Form link was distributed via email to students of the Kalimantan Institute of Technology. Validation of online respondents was ensured by respondents filling in at least 2 times visiting Hospital X, Balikpapan City during the period 2021 to 2023 so that the answers from respondents online were considered relevant and could be used in this study. while the distribution of questionnaires offline was carried out by directly approaching respondents who were around Hospital X, Balikpapan City to ask for their time to respond and fill out the questionnaire.

**Table 3.** Priority Weight Values of Variables and Sub Variables

| Variables | Weight Value | Sub Variables | Weight Value |
|---|---|---|---|
| Mobility | 0.252 | Assistance for safe driving in ambulances | 0.207 |
| | | Pedestrian area | 0.195 |
| | | Automatic Door | 0.194 |
| | | Smart Parking System | 0.208 |
| | | Children's Playroom | 0.197 |
| Energy Management | 0.208 | Smart meters for electricity, gas and water | 0.293 |
| | | Smart Renewable Energy | 0.354 |
| | | Heating, Ventilation, and Air Conditioning (HVAC) | 0.353 |
| | 0.195 | Wi-fi Internet Network | 0.339 |

| Variables | Weight Value | Sub Variables | Weight Value |
|---|---|---|---|
| Network and Telecommunication | | 3G-5G internet network | 0.336 |
| | | Integrated service web-site publishing | 0.289 |
| | | Automatic attendance using fingerprint | 0.369 |
| Waste and Waste Management | 0.197 | Centralized temporary waste disposal | 0.300 |
| | | Smart Waste Bins | 0.353 |
| | | Smart Waste Water Treatment | 0.347 |
| Health | 0.149 | Floor with Emergency Support | 0.210 |
| | | Medical sensors monitor chronic disease patients | 0.237 |
| | | Health Mobile | 0.203 |
| | | Smart infusion pump with RFID | 0.187 |
| | | Electronic Medical Records | 0.164 |

Based on **Table 3.** After testing the validity and reliability, it was continued by analysis in determining the priority of smart infrastructure implementation using the Analytical Hierarchy Process (AHP) method, from the analysis obtained in the form of weight values for each variable and sub-variable, determining the priority level based on the largest to smallest weight value. The priority levels for smart infrastructure implementation are:

1. Mobility

The main priority variable in the implementation of smart infrastructure is Mobility with a weight value of 0.252, the Mobility variable is an infrastructure that leads to the movement process starting from road access, land, and facilities in the transfer process such as lifts and ambulances. In the Mobility variable there are sub variables as indicators in the implementation of smart infrastructure, based on the results of the Analytical Hierarchy Process (AHP), the main priority scale in the Mobility sub variable is the Smart Parking System with a weight value of 0.208, followed by Assistance For Safe Driving in Ambulances with a weight value of 0.207, Children's Playroom with a weight value of 0.197, Pedestrian Area with a weight value of 0.195, and Automatic Doors with a weight value of 0.194. The existing condition for the parking lot at Hospital X in Balikpapan City can be said to be quite spacious, however, with the construction of a new building in the Hospital X in Balikpapan City area and the absence of a parking lot in the emergency unit building area, it is necessary to add a parking lot so that there will still be a vehicle circulation route, in addition, the parking conditions for motorbikes and cars are still flat land with no parking building, Based on the standards of the Regulation of the Minister of Health of the Republic of Indonesia No. 40 of 2022, it states that the land/area for parking must have a capacity of at least 20% of the total building area and the parking lot must not reduce the designated green area. Therefore, Hospital X in Balikpapan City can consider the construction and addition of parking lots with a Smart System Parking approach so that it can provide convenience in vehicle circulation for visitors and staff. Smart System Parking is one of the technology systems that uses various sensors and smart devices to optimize and manage the parking process in the parking area to increase efficiency, security and user comfort. Based on the Smart Building Nusantara manual (20), there are functional requirements that can be applied in the implementation of Smart System Parking, namely Real-Time Monitoring, Accurate Detection, Easy Navigation, Reservation System , Integration With Other Systems, Maintenance, Security, Energy Efficiency, Compliance, Data Analysis, User Experience.

2. Energy Management

The second priority variable in the implementation of smart infrastructure is Energy Management with a weight value of 0.208, the Energy Management variable is an infrastructure that leads to the energy management process by utilizing technology such as temperature and air sensors, as well as resource consumption monitoring for water and electricity. In the Energy Management variable there are sub-variables as the main indicators in the implementation of smart infrastructure, namely Smart Renewable Energy with a weight value of 0.354, followed by Heating, Ventilation, and Air Conditioning (HVAC) with a weight value of 0.353, and Smart Meter Electricity, Gas, and Water with a weight value of 0.293. Smart Renewable Energy is one concept in managing energy in buildings using renewable energy sources. Smart Renewable Energy can be implemented using tools or technologies such as hydroelectric power plants, solar power plants, rooftop solar panels, floating solar panels, bioenergy, and other technologies such as green hydrogen into the building's energy infrastructure so as to help reduce dependence on fossil fuels, reduce carbon emissions, form sustainable buildings and save costs in the long term (20). Meanwhile, the existing conditions for the application of renewable energy have been applied to the new building at the X Hospital in Balikpapan City with the installation of a Solar Power Plant (PLTS) on the top floor of the building, so that 50% of the electricity usage comes from the Solar Power Plant (PLTS). Therefore, this application can be maximized in each building in the area of Hospital X in Balikpapan City, especially in the old building and other buildings.

3. Waste and Waste Management

The third priority variable in the implementation of smart infrastructure is Waste and Waste Management with a weight value of 0.197, the Waste and Waste Management variable is an infrastructure that leads to the waste and waste management process starting from the availability of trash bins, the sorting process, to the final disposal stage. In the Waste and Waste Management variable, there are sub-variables as the main indicators in the implementation of smart infrastructure, namely Smart Waste Bins with a weight value of 0.353, followed by Smart Waste Water Treatment with a weight value of 0.347, and Centralized Temporary Waste Disposal with a weight value of 0.300. Based on interviews and the 2019-2023 Renstra document, the existing condition for waste bins in hospitals already exists but is still done manually in the management and collection of waste with a predetermined waste collection schedule, besides that there is still a need for additional capacity and facilities in the management of solid and liquid waste. To make it easier to monitor the garbage or waste in the trash bin, especially when it has exceeded 2/3 of the bag, it can be done by adding automatic technology that provides notification to be lifted immediately, this can be done by implementing the smart waste bins concept. Smart waste bins are a system of using technology in waste management using sensors and integrated with the Hospital X in Balikpapan City so that it can provide operational schedule information systematically, detect the level of fullness of the trash bin/shelter, and provide information related to the transportation of waste in trash bins that have exceeded capacity. The operational requirements for implementing smart waste bins in the Smart Building Nusantara manual (20) are Automated Waste Sorting; Real-Time Data; Data Analytics; Remote Monitoring And Control; Customizable Alerts And Notifications; Health And Safety; Durability And Weather Resistance; User-Friendly Interface; Energy Efficiency and Flexibility.

4. Network and Telecommunication

The fourth priority variable in the implementation of smart infrastructure is Network and Telecommunication with a weight value of 0.195, the Network and Telecommunication variable is an infrastructure that leads to the use of internet networks and the process of providing services or administration. In the Network and Telecommunication variable there are sub-variables as the main indicators in the implementation of smart infrastructure, namely Automatic Attendance Using *Fingerprint* with a weight value of 0.369, followed by Wi-Fi Internet Network with a weight value of 0.339, 3G-5G Internet Network with a weight value of 0.336, and Publishing Integrated Service Web-Site with a weight value of 0.289. The existing condition at Hospital X in Balikpapan City in the use of automatic attendance with fingerprints is that it has been applied to the staff, so that the use of the fingerprint system can be developed with use in the administrative service process. The use of fingerprints in the administrative service process has been carried out at Sinjai Hospital and Soedirman Hospital Kebumen using fingerprint technology for *BPJS Kesehatan* services by recording participant fingerprints to verify the participant's right to receive a Participant Eligibility Letter (SEP) for the Health Insurance Program in the National Social Security System. This approach aims to accelerate the administration of participants and Advanced Referral Health Facilities (FKRTL), as well as to prevent misuse of JKN-KIS cards by ineligible parties.

5. Health

The fifth priority variable in the implementation of smart infrastructure is Health with a weight value of 0.149, the Health variable is an infrastructure that can provide efficiency in terms of providing health services such as the long-distance consultation process between patients and doctors, and an easy access to find out the condition of patient medical records. In the Health variable there are sub-variables as the main indicators in the implementation of smart infrastructure, namely Chronic Disease Patient Monitoring Medical Sensors with a weight value of 0.237, followed by Floors with Emergency Support with a weight value of 0.210, Health Mobile with a weight value of 0.203, Smart Infusion Pumps with RFID obtained a weight value of 0.187, and Electronic Medical Records with a weight value of 0.164. Based on interviews with the hospital, this chronic disease medical sensor sub-variable is very good to implement, especially in the implementation of digital smart infrastructure, but at Hospital X, Balikpapan City, this sub-variable does not yet exist. For the standard in the use of medical sensors, efficiency is prioritized in its use, one example is the development of a chronic disease monitoring system in patients with end-stage heart failure, by utilizing medical data designed by various biosensors embedded in the indoor area around the patient. This system focuses on patients who have special concerns such as the need for mechanical circulation, assistance with ventricles and artificial hearts to patients, and provides a comfortable and non-intrusive way to monitor important vital parameters over a long period of time (21) .

## 4. Conclusion

The implementation of Smart Infrastructure at Hospital X, Balikpapan City can be done with 5 alternative implementations, including:

1. Smart Infrastructure Mobility with the implementation of smart parking system
2. Smart Infrastructure Energy Management with the application of smart renewable energy
3. Smart Infrastructure Waste and Sewage Management with the implementation of smart waste bins
4. Smart Infrastructure Network and Telecommunications with the implementation of automatic attendance using fingerprints, and
5. Smart Health Infrastructure with the application of medical sensors to monitor chronic disease patients

## References

[1] Rizkinaswara L. aptika.kominfo.go.id. 2022. Gerakan Menuju 100 Smart City. Tersedia pada: https://aptika.kominfo.go.id/2022/07/gerakan-menuju-100-smart-city-2/

[2] Perboli G, De Marco A, Perfetti F, Marone M. A new taxonomy of smart city projects. *Transp Res Procedia* [Internet]. 2014;3(July):470–478. Tersedia pada: http://dx.doi.org/10.1016/j.trpro.2014.10.028

[3] Albino V, Berardi U, Dangelico RM. Smart cities: Definitions, dimensions, performance, and initiatives. *Journal Of Urban Technoogy* [Internet]. 2015;22(1):3–21. Tersedia pada: http://dx.doi.org/10.1080/10630732.2014.942092

[4] Jihana. klikbalikpapan.com. 2022. Wujudkan Smart City Balikpapan. Tersedia pada: https://klikbalikpapan.com/wujudkan-smart-city-balikpapan/

[5] Zou X, Ma S, Xin S. An Analytical Hierarchy Process Approach for Smart City Assessment in Japan: From Concept to Indicators. *Int Rev Spat Plan Sustain Dev*. 2022;10(2):58–72. DOI : 10.14246/irspsd.10.2_58 .

[6] Arrohman ZD, Andriani W, Gunawan G. Analisis Penerapan Smart Living Dalam Pembangunan Smart City Di Kota Tegal. *Jurnal Cahaya Mandalika* [Internet]. 2023;4(2):347–54. Tersedia pada: https://ojs.cahayamandalika.com/index.php/JCM/article/view/1448

[7] Miller E. Integrated Urban Modelling for Smart City Design. In Proceedings of the RISUD Annual International Symposium 2016-Smart Cities (RAIS 2016), Hong Kong, China. 2016;23–4.

[8] Selim AM, ElGohary AS. Public–private partnerships (PPPs) in smart infrastructure projects: the role of stakeholders. *HBRC Journal* [Internet]. 2020;16(1):317–33. Tersedia pada: https://doi.org/10.1080/16874048.2020.1825038

[9] Sari DM, Ibad MZ, Tanjung AS. Kajian Pengembangan Smart Infrastructure Pada Aspek Prasarana Perkotaan Di Kota Bandar Lampung. *Jurnal Perencanaan dan Pengembangan Kebijakan*. 2022;02(August):1–12. DOI: 10.35472/jppk.v2i2.608

[10] Dianti EN, Khoirunnisa OG, Hidayah SR. The Effect of Modern Strategy Implementation on Smart Infrastructure on Increasing Employee Performance at University in Indonesia. *J Inf Syst Explor Res.* 2022;1(1):25–38. DOI: 10.52465/joiser.v1i1.102

[11] Noviathie L. Urgensi Pembaharuan Regulasi Perlindungan Data Konsumen Kesehatan Atas Tanggung Jawab Rumah Sakit Dan Badan Penyelenggara Jaminan Sosial Di Era Digital Menuju Smart Hospital 4.0. 2022;1–28. *Artikel Tesis.* Ilmu Hukum, Universitas Pasundan. Bandung, 2022;1–28. Tersedia Pada: Http://Repository.Unpas.Ac.Id/58254/

[12] Vecchia G Della, Gallo L, Esposito M, Coronato A. An infrastructure for smart hospitals. *Multimed Tools Appl*. 2012;59(1):341–62. DOI: 10.1007/s11042-010-0695-8

[13] Božić V. Smart User in Smart hospital. 2023;7. Tersedia pada: https://www.researchgate.net/publication/367664964_Smart_User_in_Smart_hospital

[14] Kwon H, An S, Lee HY, Cha WC, Kim S, Cho M, et al. Review of Smart Hospital Services in Real Healthcare Environments. *Healthc Inform Res.* 2022;28(1):3–15 DOI: 10.4258/hir.2022.28.1.3.

[15] Utari PS, Firmansyah I. Pengaruh Kualitas Pelayanan dan Fasilitas Terhadap Kepuasan Pasien Rawat Jalan Pada Rumah Sakit Bhayangkara Setukpa Sukabumi. *J Mhs Manaj*. 2021;2(2):60–78.

[16] Puspitasari WD, Febrinita F. Pengujian Validasi Isi (Content Validity) Angket Persepsi Mahasiswa terhadap Pembelajaran Daring Matakuliah Matematika Komputasi. *J Focus Action Res Math*. 2021;4(1):77–90. DOI: 10.30762/factor_m.v4i1.3254

[17] Perdana SA. Penduga Rataan Geometrik Pada Sampel Himpunan Terurut Untuk Distribusi Normal. *Jurnal Gantang* Vol. 2018;Iii(1):9–16. Tersedia Pada: http://ojs.umrah.ac.id/index.php/gantang/index

[18] Rahmansyah N, Lusinia SA. *Buku Ajar Sistem Pendukung Keputusan.* Padang: Pustaka Galeri Mandiri; 2021.

[19] Padmowati R de lima endang. Pengukuran Index Konsistensi Dalam Proses Pengambilan Keputusan Menggunanakan Metode AHP. Semnas Informatika. UPN "Veteran" Yogyakarta, Indonesia, *23 Mei 2009*; E80–E84.

[20] Berawi MA, Yatmo YA, Sari M, Larasati SP, Roberts E. *Nusantara ' s Smart Building Guideline* [Internet]. Ali Berawi M, Susantono B, editor. Jakarta; 2023. 104 hal. Tersedia pada: https://www.ikn.go.id/storage/thd/smart-building-books/smart-building-guideline-eng-b5-200923.pdf

[21] Holzinger A, Röcker C, Ziefle M. From smart health to smart hospitals. *Lect Notes Comput Sci (including Subser Lect Notes Artif Intell Lect Notes Bioinformatics)*. 2015;8700:1–20. DOI: 10.1007/978-3-319-16226-3_1