Key Indicators for Effective Implementation of Smart City

Standards in Indonesia During the Covid-19 Pandemic: A Case Study of Four Cities

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Abstract

Resources management owned by smart cities in Indonesia must be effective and efficient because the concept of urban development is based on information technology principles application. To ensure the environment is safe for human health is necessary to apply standards. SNI ISO 37122 implementation has affected the effectiveness of health protocols. Indicators in the standard are arranged to detect the COVID-19 control spread and prevention. The linkage of indicators and health protocols resulted in the indicators scoring that affected the pandemic spread. The indicator's data is obtained from personal authority guided by a questionnaire. This research contains evidence of the smart city policy of the pandemic spreading in cities. Effected indicators are decided involving the expert's judgment. Jakarta is one leading cities that has implemented the indicators and has the lowest pandemic ferocity, as proven by its low IFR and CFR values. This research might be a guide for policymakers to adopt.

Keywords: *COVID-19 Pandemic, Smart City, Health Protocols, Urban Environment, Urban Sustainability, Indonesia*

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Introduction

The pandemic of COVID-19 affects the world's cities and society's daily life functionally. This phenomenon causes health problems and disruption of community activities that can cause economic, social, and cultural problems (Yang & Chong, 2021; Tampubolon et al., 2021). The regulation and prevention during pandemics require policy coordination, management, and technology updates (He et al., 2021). Therefore, since COVID-19 spread, every country has been equipped with strong knowledge to react and make appropriate decisions in mitigating the spread of the virus. Technology is currently being utilized extensively to track the virus's spread, as demonstrated in Singapore (Chang & Das, 2020). One of the smart city concepts is to utilize technology in policy implementation (Inn, 2020).

Smart cities are associated with various technologies usage or innovative concepts to unify urban systems and urban services management to enhance resource utilization efficiency, optimization, and citizens' life quality improvement (Yang & Chong, 2021). Particularly, The COVID-19 pandemic shows the benefits and needs of multiple smart city platforms for pandemic prevention and pandemic management. Smart cities can improve the prosperity of people in city areas when providing comprehensive services access (Picatoste et al., 2018).

The National Standardization Agency of Indonesia has developed standards related to indicators for smart cities, namely SNI ISO 37122, which is an identical adoption of ISO 37122. The preliminary research conducted by Tampubolon et al. (2021) yields eleven sectors of nineteen in SNI ISO 37122 that affect the spread of the COVID-19 pandemic. Selected sectors are determined based on scores obtained from each sector according to expert judgment. The selected sectors are economy, telecommunication, environment, climate change, finance, governance, health, recreation, safety, sport, culture, urban planning, and water, consisting of twenty-one indicators that might restrict the virus's spread in Indonesia.

This paper is a continuance and further discussion of the preliminary research conducted by Tampubolon et al. (2021), which is supposed to describe the implementation of selected sectors, including the indicators in four cities in Indonesia: Yogyakarta, Bandung, Jakarta, and Banyuwangi. The study in the four cities wants to analyze the level of control effectiveness and prevention of COVID-19 based on smart city standards. The standard is represented by primary data of indicators in the ISO 37122 standard, which has been implemented by the city. The effectiveness level is confirmed based on the number of infected people from the disease, the number of deaths people from the disease, and the number of recovered people from the COVID-19 disease. According to this research, the smart city development policy was probably adjusted caused of the COVID-19 cases. These four cities would provide evidence, and represent that the smart cities standard would handle problems and particularly COVID-19 spread these days effectively. The implication is that the growth of the city sector, which helps contain future pandemics, can be given priority by city policy.

Literature Review

Establishment of Indonesian Smart City

Land transformation in Indonesia, which is caused by several factors such as urbanization, economic growth, technological capability, culture, and tradition, results in a few environmental problems that affect the land structure is no longer fit the urban population

growth. Since the number of populations keeps increasing, city problems are getting more complex, and typical solutions are no longer able to be resolved (Supangkat et al., 2018). Therefore, an extraordinary solution is needed to build an innovative, integrated, and effective city system.

Indonesia has made a master plan and programs for smart city development to accelerate the potential and competitiveness of the region and to improve its services to the community. Smart city concepts are adjusted to the Indonesian context, which is defined as a city that can manage all resources effectively and efficiently to solve city problems by utilizing innovative, integrated, sustainable solutions in certain city services to improve the quality of life (Supangkat et al., 2018). In 2022, there will be 191 city districts, out of a total of 514 city districts in Indonesia, which have the potential for smart city development concepts and join “The Movement Towards a Smart City." According to government regulation No.28 2018, which concerns the cooperation in regional through smart people, smart economy, smart mobility, smart government, smart environment, and improved quality of life. Smart living needs government, stakeholders, and all related parties must work together in providing services of each aspect effectively and efficiently to actualize and succeed in the smart city program. Smart city development includes urban technologies such as the construction of primary infrastructure, technology for transportation, green buildings, and environment-based waste management.

The European Smart City working group has operationalized the smart city concept along six themes: smart governance, smart mobility, smart environment, (smart people, smart economy, and smart living (Giffinger et al., 2007). Most smart cities in Indonesia have provided one or more dimensions of a smart economy, smart living, smart society, smart branding, smart governance, and smart environment (Offenhuber, 2019). Considering from government's vision of smart cities, one of the innovation programs that is being intensively developed in Indonesia is adopting information technology to improve city performance. These aspects are economics, city administrations, and social practices responding to the city development, and smart city inceptions must follow the city's needs and adopt the local needs into their platform (Kusumastuti, 2022).

Smart City Standards

Smart city concepts are formed to help cities solve issues by providing innovative and efficient completion based on information technology. According to Tan and Taeihagh (2020), there are drawbacks to the smart city implementation process in developing countries, namely budget restraints, fundamental infrastructure investment deficiency, fragmented authority, insufficient regulation, under supply of ingenious human resources, and lack of infrastructure preparedness, environmental concerns, citizen engagement, also shortage technology literacy among the citizens. International standard organizations and national standard organizations collaborated to develop the standards of a smart city. The intricacy of smart city system handling is covered by a few standards, so combining the different stakeholders of each city and standards organization brings advantages to building a suitable system. Ministry of Communication and Information Technology adopted the concept of smart city that was promoted by Citiasia Inc. Otherwise, the Smart city term is used consecutively with green and energy cities in European literature. The difference is that American literature is a way of technology-driven, while European literature sets the “city”

as the center of attention. Vision differences cause the contrasting dimensions of both sustainable cities and smart cities. A sustainable city's dimensions are economics, governance, socio-cultural, green, and flexibility, whereas the smart city's dimensions are smart economy, smart governance, smart living, smart branding, smart society, and smart environment (Kusumastuti, 2021). The sustainable urban system developed by Bappenas is adopted by the International Organization for Standardization (ISO) (Kusumastuti, 2021).

ISO/TC 268 is the technical committee on sustainable cities and communities established by the International Organization for Standardization. This technical committee develops the international standards that would encompass the requirements, guidelines, frameworks, and supporting techniques related to achieving sustainable development by considering resilience and intelligence. The standard of the smart city represents and establishes the definition and methodology for sets of indicators to aim and measure the smart city service performance and quality of life. Besides, the standard of a smart city also defines relevant activities to smart community aspects, namely energy, waste, water, information, and communication technology (ICT). The intelligence concept intends to yield a relevant performance to smart solutions that could apply information technology and follow sustainable development and community resilience (Tampubolon et al., 2021).

The standards of a smart city can be applied to one type or several types of community infrastructure, which should involve all social levels. Developed standards arranged by the Technical Committee(TC) and Sub-Committee (SC) of sustainable city and community where for the first group on sustainable development in communities: ISO 37101 management system for sustainable development, ISO 37120 indicators for city services and life quality, and ISO 37122 indicators for smart cities and; for the second group on smart community infrastructures: ISO/TR 37150 review of existing activities relevant to metrics, ISO 37151 principles and requirements for performance metrics, and ISO 37153 maturity model for assessment and improvement.

According to Tampubolon et al. (2020) research, based on SNI ISO 37122, there are nineteen sectors that were judged, and each stakeholder gave a score. The score for no role is 0, and the score for playing a role is 1 through the focus group discussion (FGD). The sectors that score 0.5 and above are sectors that could participate in preventing COVID-19 from spreading in the community. The research yields based on nineteen sectors found that from nineteen sectors on SNI ISO 37122, eleven sectors and twenty-one indicators have roles in restricting the virus spread. The indicators in the smart city standard are parameters or components in a city used to implement policies set in order to control the COVID-19 pandemic so that it is more effective than cities that do not implement this standard.

COVID-19 Prevention and Countermeasures in Indonesia

The covid-19 pandemic caused health problems and ruined the society's entire structure, which formed economic, social, and cultural problems. The socio-economic conditions of Indonesia's citizens are getting weak, specifically in a few high rates spread areas such as Jakarta, Depok, Bogor, Bekasi, and Tangerang. COVID-19 crucially interfered with the economy of Indonesia by the end of the first quarter of 2020 while the government reacted with stimulus packages with allocated Rp 87.55 trillion to moderate the effects on the economy, health, living, and jobs (Olivia et al., 2020). Indonesia's government decided on the social

and physical restrictions on small, medium, and large-scale medical masks to prevent and control the spread of COVID-19. The use of medical masks and social distancing has been implemented to minimize the infection risk, which can be more effective if the individual has high awareness (Aldila et al.,2020).

According to the previous study, the government could choose two methods to regulate society such as 1) How to implement the social restrictions without reducing the freedom of the citizens; otherwise, the government and society can be observed and controlled with technology, and 2) How to implement a "lockdown" policy or flexible social restrictions based on city's health status that is constantly updated and could be accessed online(Sonn, Kang, & Choi, 2020). This pandemic is a challenging situation that needs to be dealt with and managed by central and regional governments.

Some policies which are related to pandemic handling and health protocols are published. For the purpose of preventing and controlling the virus spread, the Indonesia government set up the 3M (wear a mask, wash hands, maintain social and physical distance) health protocols for citizens in public facilities and places built upon the Decree of the Minister of Health of the Republic of Indonesia Number HK.01.07 / MENKES / 382 / 2020. To support the implementation of health protocols, underline the implementation of the 3T policy (testing, tracing, treatment) as the guidelines, prevention to control for COVID-19 spread (based on the Minister of Health regulation number HK.01.07 / MENKES / 413 / 2020). Both programs (3M policy and 3T policy) are combined and cannot be separated to break the chains of Coronavirus transmission during the pandemic. The program is also integrated with the program of business incentives supply for Micro, Small Medium Enterprises established by the Committee for COVID-19 Handling and National Economic Recovery (KP-CPEN) (Tampubolon et al., 2021). All commercial travel was also restricted, and this action was initially an attempt to control the annual home pilgrimage (mudik) from Jakarta and another big city at the end of the fasting month (Olivia et al., 2020).

Smart City During the Pandemic

Research conducted by Pratama et al. (2023) discusses whether smart cities in Indonesia are better at managing the COVID-19 crisis compared to non-smart cities. This study focuses on the impact of urban governance on city performance in dealing with the pandemic. The findings suggest that smart city status does not have a statistically significant impact on the spread of the COVID-19 pandemic. This study highlights the lack of integration of technological dimensions into health systems and urban governance in the context of a public health crisis. Amandita et al. (2023) explained the implementation of digital health services in handling COVID-19 in Indonesia. This study compares the implementation of digital health services between regions in Indonesia and analyzes strategies in the health sector that are appropriate in the era of digital transformation. The research was conducted using qualitative methods, a systematic literature review, and SWOT analysis techniques. The results show that digital health services dominate the West and Central parts of Indonesia, with various factors influencing differences in the implementation of digital health services in each region.

In concept, it has nine main smart categories: smart energy, smart healthcare, smart mobility, smart technology, smart building, smart infrastructure, smart security, smart

governance, and smart citizen (Awaluddin, 2016). Onoda (2020) stated that the importance of smart concepts for waste management during the pandemic had become a catalyst for accelerating the application of smart cities due to the need for medical waste management in handling COVID-19 spread. Smart citizens play a role in handling COVID-19, which is the individual and social responses that are the most important thing.

Many innovations are created to assist the smart city program based on main parameters, such as applications based on information technology to resolve several COVID-19 issues. The various applications are set up differently in each smart city in Indonesia. These applications have different purposes, functions, and advantages, such as informational apps, government services, health care apps, multipurpose apps, administration apps, etcetera. Smart cities in Indonesia should implement applications to support activities and programs that refer to all elements of smart cities and those various ICT-based applications in an effort to minimize COVID-19 (Rachmawati et al., 2021).

Many cities have different applications to handle and limit the virus-spreading risk. The Capital Special Territory of Jakarta government has developed an app, namely "JAKI" with a tracking feature in order to control the COVID-19 dispersion. This app can be utilized to scan the movement of citizens via a QR code. Synchronously, this app can indicate the COVID-19 patient's exact locations for the last 14 days. Another city that launched an application is Bandung. The Bandung government has configured and published an app named "PIKOBAR" to undertake the COVID-19 pandemic. Through this application, the government can discover the eligible citizens who will provide the social aid, and this app also displays information about the recipient and the source of funds. Rachmawati et al., 2021 stated that this "Pikobar" application also includes information concerning the total of COVID-19 patients, a map of dispersion location, emergency phone calls, self-health checks, and complaints. There are more cities with their self-built-up ICT-based various applications as an implementation of smart cities programs to participate in risk reduction of COVID-19 dispersion.

Data and Methods

This paper aims to find the indicators and sectors in each city's preparation to face the COVID-19 spread and identify the smart city's role in pandemic control and prevention. This approach is created to disclose the significant linkage between factors and explain how the smart city concept goes. The method used in this research is the descriptive method. The overall research design is revealed in Figure 1.

This research begins by identifying the implementation of eleven sectors and includes twenty-one indicators based on preliminary research. Currently, the smart city concept has not been widely implemented in cities in Indonesia. The reason for selecting the four cities in this research is to represent cities in Indonesia that have implemented the smart city concept (smart city pilots in Indonesia). The cities that are the objects of this research are Yogyakarta, Bandung, Jakarta and Banyuwangi. These four cities are also types of cities that represent all cities in Indonesia. Jakarta represents a metropolitan city as the capital; Bandung is a city with quite high IT development; Yogyakarta, in general, is a developing cultural city; and Banyuwangi is a developing agricultural district. Furthermore, these four cities are also willing to help provide the smart city indicator data needed in this research.

After identifying the implementation of eleven sectors and including twenty-one indicators, data was then collected on compliance with the implementation of eleven sectors and including twenty-one indicators listed in SNI ISO 37122 based on preliminary research. Data and assessment available in the survey design, which consists of twenty-one indicators of eleven sectors, are fulfilled by the regional government or stakeholders of each city. Each representation is invited to assess and fill in the filtered indicators and sectors listed in SNI ISO 37122 based on preliminary research. The assessed sectors include economy, environment, climate change, finance, governance, health, recreation, safety, sport and culture, telecommunication, urban planning, and water. In accordance with survey results, each indicator of all cities is scored as 0 (not available), 1 (good), or 2 (incredibly good), which continues equalization and bias prevention. The ratio is calculated in units per 100,000 population.

In this research, IFR and CFR measurements were also carried out on COVID-19 cases to measure the level of massive spread of COVID-19 in a region. According to the World Health Organization (WHO), there are two measurements used to assess the proportion of infected individuals with a fatal outcome. The measurements are IFR, which estimates the proportion of death among all infected individuals, and CFR, which estimates the proportion of death among identified confirmed cases. The data collected to calculate the IFR and CFR values are data on the number of deaths from disease, the number of infected from disease, and the number of recovered from disease. Formulas for IFR and CFR are written as follows:

$$IFR = \frac{\text{Number of deaths from disease}}{\text{Number of infected from disease}} \times 100$$

$$CFR = \frac{\text{Number of deaths from disease}}{\text{Number of deaths from disease} + \text{Number of recovered from disease}} \times 100$$

The final stage in the research is identifying the relationship between the application of smart city indicators and the ability of each city to control the spread of COVID-19. The assessment process for each sector is linked to measuring the massive spread of COVID-19 in a region (IFR and CFR measurements). This relationship will be explained descriptively based on the facts of the conditions found in the region. From the results of this research, it can be seen the relationship and role of implementing smart city indicators during the pandemic in controlling the spread of COVID-19.

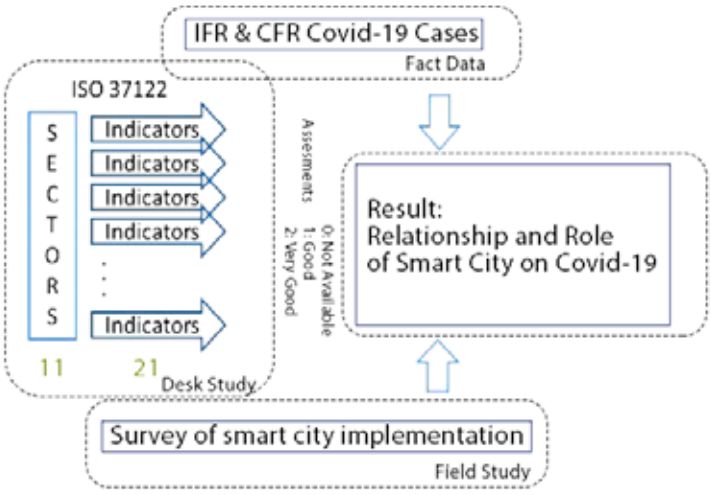

Figure 1. Overall research design.

Results

Identify the Sectors of Each City

Refers to Tampubolon et al. (2021) previous research, eleven sectors of nineteen sectors in SNI ISO 37122 participate in restricting the COVID-19 spread. The sectors are economy, environment, climate change, finance, governance, health, recreation, safety, sport and culture, telecommunication, urban planning, and water. This research discussed the implementation level of each sector in Indonesia's several cities and identified the linkage with COVID-19 spread control and prevention.

Economy

The economic sector has two indicators from four cities in Indonesia, as shown in Figure 2. The formed graph is based on scaling values of the original values. This aims to present several indicator values which have different units in a single graph. This economy sector in SNI ISO 37122 contributes to the control and prevention of pandemics, where the first indicator is about the provision of online city services, and the second indicator is about the workforce in the ICT sector.

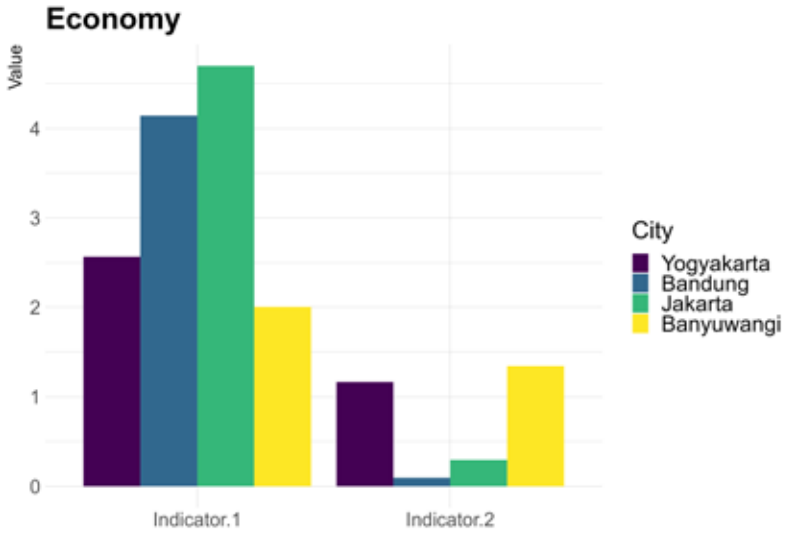

Figure 2. The economy sector values.

Bandung and Jakarta are the leading cities based on indicator 1, in which the number of service contracts that provide the city services and contain an open data policy is more than 10.000 contracts every year. In indicator 2, Yogyakarta and Banyuwangi lead among the other two cities. The number of workers employed in occupations in the information and communications technology (ICT) sector per population in both cities is 14.6 % and 22.1 %.

Environment and Climate Change

The value of each environmental and climate change indicator of the four cities is assessed using a scaled value from the original value. This aims to present several indicator values which have different units in a single graph. This environment and climate change sector in SNI ISO 37122 contributes to the control and prevention of pandemics, was the first indicator of the number of real-time remote air quality monitoring stations per square kilometers, and the second indicator of public buildings equipped for monitoring indoor air quality. Based on indicator 1 in this sector, Jakarta and Bandung are the leading cities of other cities even though both values are not far different from Yogyakarta. Meanwhile,

Banyuwangi does not have available data for this indicator. Indicator 2 is empty because of data unavailability for each city. If refers to the total number of public buildings within the city that are equipped for monitoring indoor air quality.

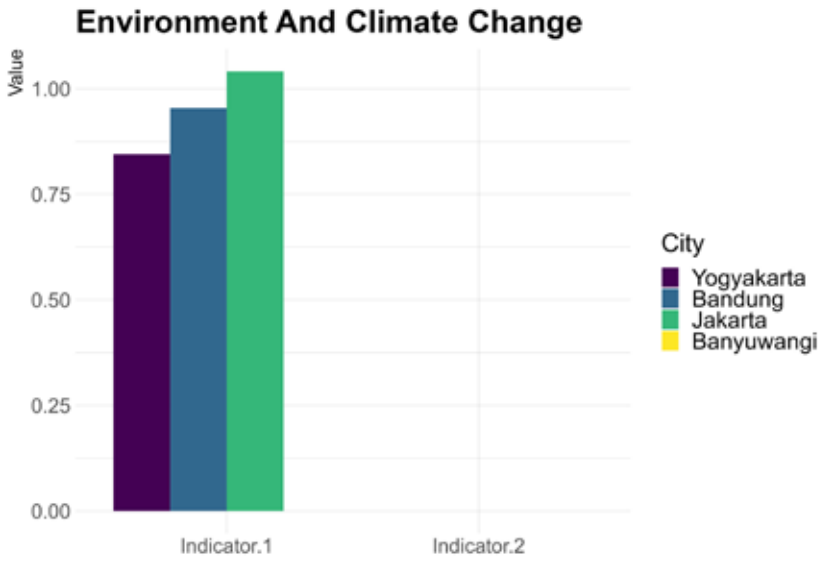

Figure 3. Environment and Climate Change values.

Finance

The graph formed is based on the scaled value of the indicator from the original financial value of the four cities. This aims to present several indicator values which have different units in a single graph. This finance sector in SNI ISO 37122 contributes to the control and prevention of the pandemic, where the main indicator of payments to the city is paid electronically based on electronic invoices.

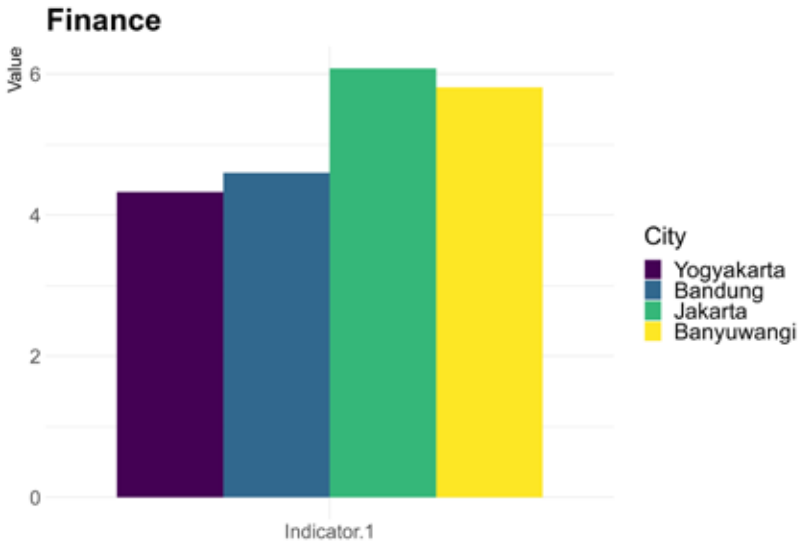

Figure 4. The finance sector values.

It is known that Jakarta and Banyuwangi are leading cities in the finance sectors. The number of payments to the city that are paid electronically based on electronic invoices in both cities Jakarta and Banyuwangi is more than 600.000 transactions. Jakarta leads because it is the capital of the Republic of Indonesia and has district authority in the trade, industry, and service sectors.

Governance

The governance indicator values in four cities in Indonesia are shown in the following graph, based on a scaled value from the original value. This aims to present the several indicators' values with different units in a single graph. The sector of governance in SNI ISO 37122 contributes to pandemic control and prevention with two indicators, namely the annual number of online visits to open city data portals per 100,000 residents (as indicator 1) and city services offered to the community and businesses through a centralized Internet interface (as indicator 2).

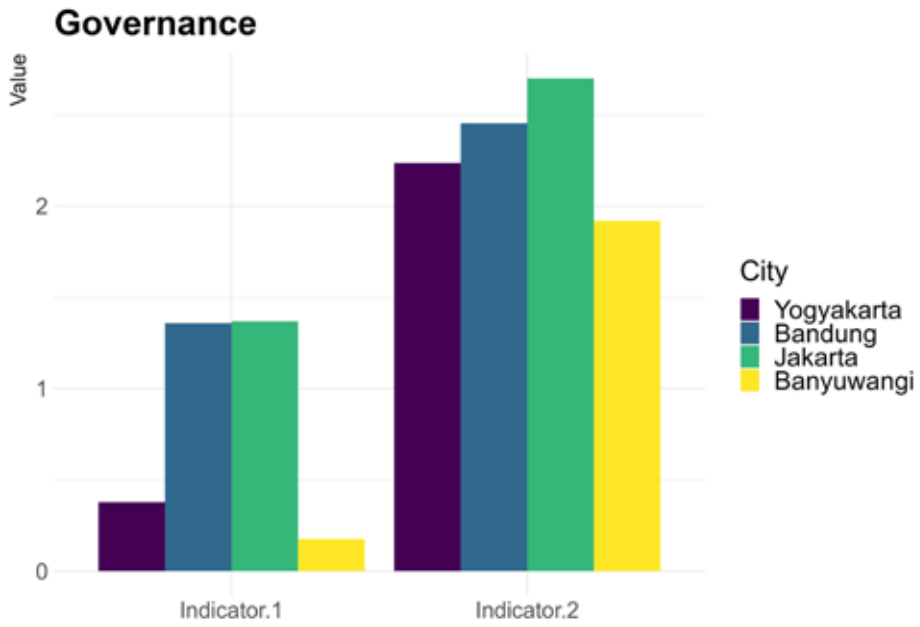

Figure 5. The governance sector values.

Bandung and Jakarta have conducted cities between four cities. The annual number of online visits to the municipal open data portal per 100.000 population in Bandung and Jakarta is more than 20 percent. Based on Indicator 2, the leading cities are also Bandung and Jakarta. This shows that both cities provide internet for things-based government administration services. It is reasonable because both cities are capital cities.

Health

The city's health indicators are reflected in the following graph, based on the scaled values from their original values. This aims to present several indicator values which have different units in a single graph. This health sector in SNI ISO 37122 contributes to the control and prevention of pandemics, where the first indicator of the city's population with an online unified health file accessible to health care providers, and the second indicator on the annual number of medical appointments conducted remotely per 100.000 Population.

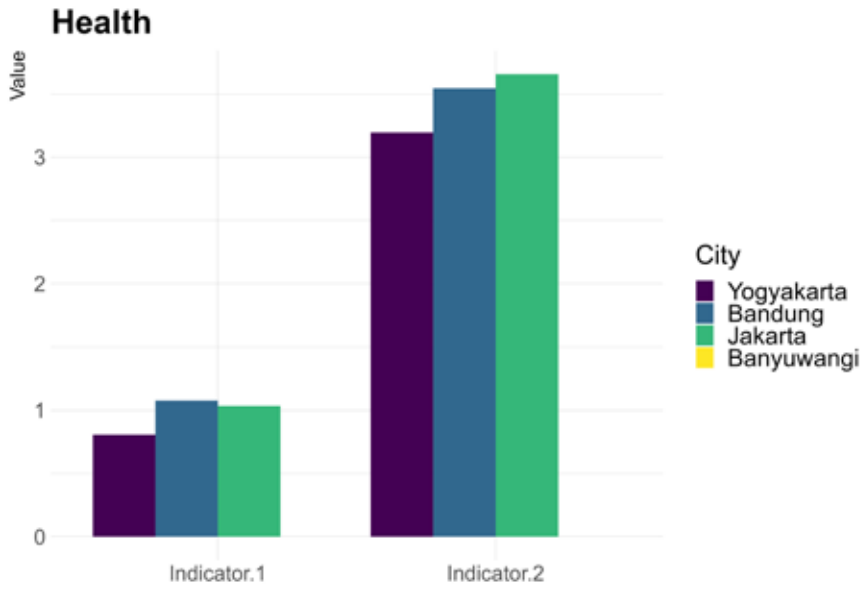

Figure 6. The health sector values.

Bandung and Jakarta also lead in the health sector, and for Banyuwangi, the data was not available. The data unavailability in some cities might represent that the database system in Banyuwangi was not stored as well, or the city does not have a system that is integrated with the internet. This is critical because patient tracking is particularly important during the pandemic.

Recreation

Based on the assessment of the scaling original value of the recreation indicator, this sector contributes to pandemic control and prevention. The main indicator is community recreation services that can be ordered online. Yogyakarta and Banyuwangi are higher rankings since both cities are tourist destinations in Indonesia. Because their natural sources are various and wondrous, the recreation sector is much greater than in other cities. Facilities of public recreation that can be ordered online possibly add value and efficiency to several tourists' management.

Safety

This sector assessment is also based on the scaling values of the original values on safety indicators. This safety sector in SNI ISO 37122 contributes to the control and prevention of pandemics, which is the main indicator of the city area covered by digital surveillance cameras. The cities that lead are Jakarta and Bandung because, in fact, at every spot in both cities, surveillance cameras are facilitated at public facilities, office buildings, and shopping centers.

Sport and Culture

The value of sports and cultural indicators in four cities in Indonesia is exhibited in Figure 9. The graph is based on the scaling values of the original values. This aims to present several indicator values which have different units in a single graph. This sport and culture sector in SNI ISO 37122 contributes to the control and prevention of pandemics, was the first indicator of the number of online bookings for cultural facilities per 100 000 popula-

tion, and the second indicator of the city's cultural records that have been digitized, and the third indicator on the number of a public library book and e-book titles per 100.000 population.

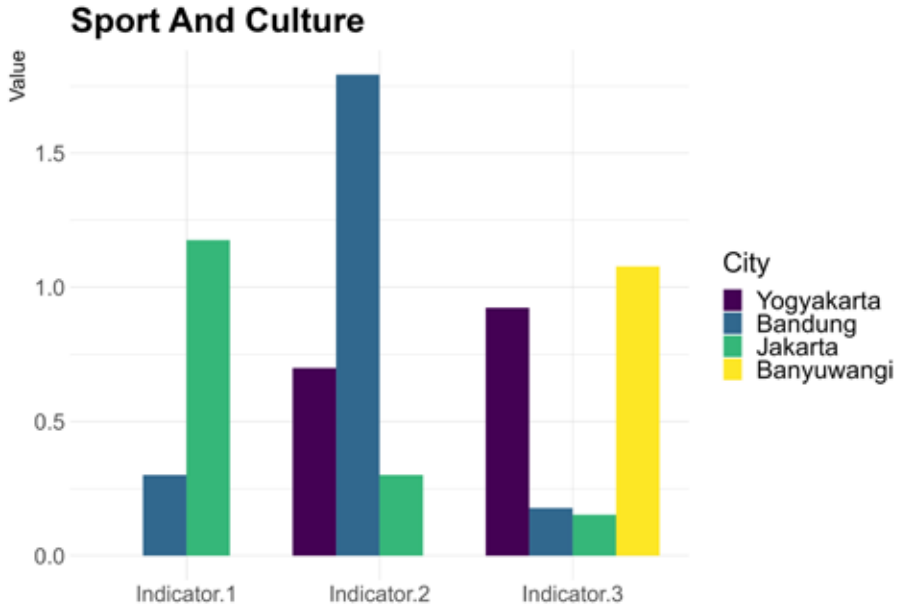

Figure 7. The sports and culture sector values.

Indicator 1 is led by Jakarta, and data source from Yogyakarta and Banyuwangi is unavailable. The number of online bookings for cultural facilities in Jakarta is 15 e-bookings. Bandung has the highest city in sports and culture sector value. The number of the city's cultural records that have been digitized is 62 of 546. In the meantime, the primary city based on indicator 3 is Yogyakarta and Banyuwangi. The number of public library books and e-book titles per population is more than 8 percent.

Telecommunication

The value of telecommunication indicators in four cities is demonstrated in Figure 10. The graph is based on the scaling values of the original values. This aims to present several indicator values which have different units in a single graph. This telecommunication sector in SNI ISO 37122 contributes to the control and prevention of pandemics, is the first indicator of the city population with access to sufficiently fast broadband, the second indicator of city area under a white zone/dead spot/not covered by telecommunication connectivity, and the third indicator on the city area covered by municipally provided Internet connectivity.

The telecommunications sector between cities are not far, but the prime city based on indicator 1 is Yogyakarta and Jakarta, but data on Banyuwangi is unavailable. In contrast, according to indicator 2, all cities have outstanding telecommunication sectors, and in Indicator 3, Jakarta is the superior of the four cities. Jakarta has been discovered as a region with a high flow of administration and business, so it was not surprising that Jakarta leads this sector.

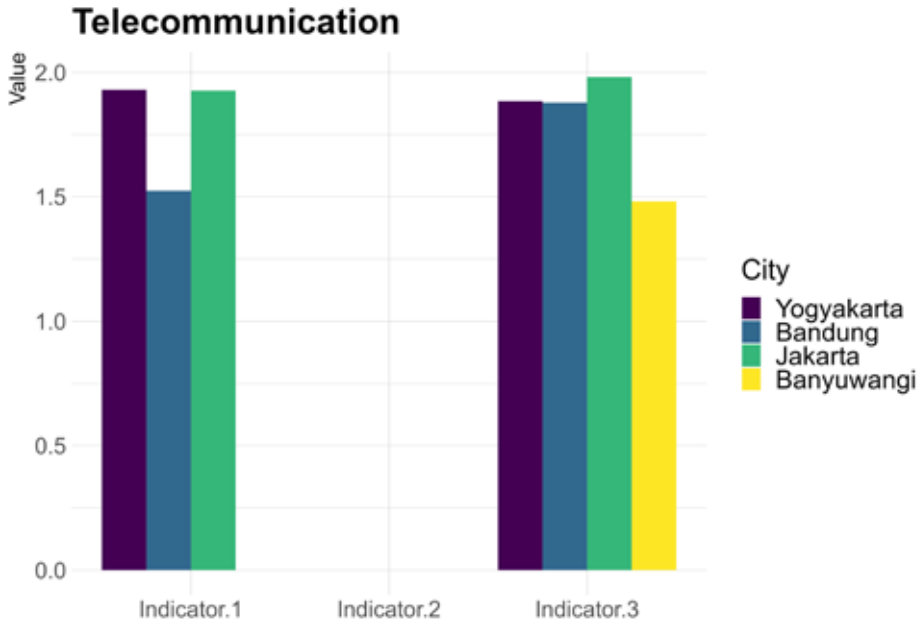

Figure 8. The telecommunication sector values.

Urban Planning

The urban planning indicators value of four cities in Indonesia is indicated in Figure 9. The graph is based on the scaling values of the original values. This aims to present several indicator values which have different units in a single graph. This urban planning sector in SNI ISO 37122 contributes to the control and prevention of pandemics, is the first indicator of building permits submitted through an electronic submission system and the second indicator of the city population living in medium-to-high population densities.

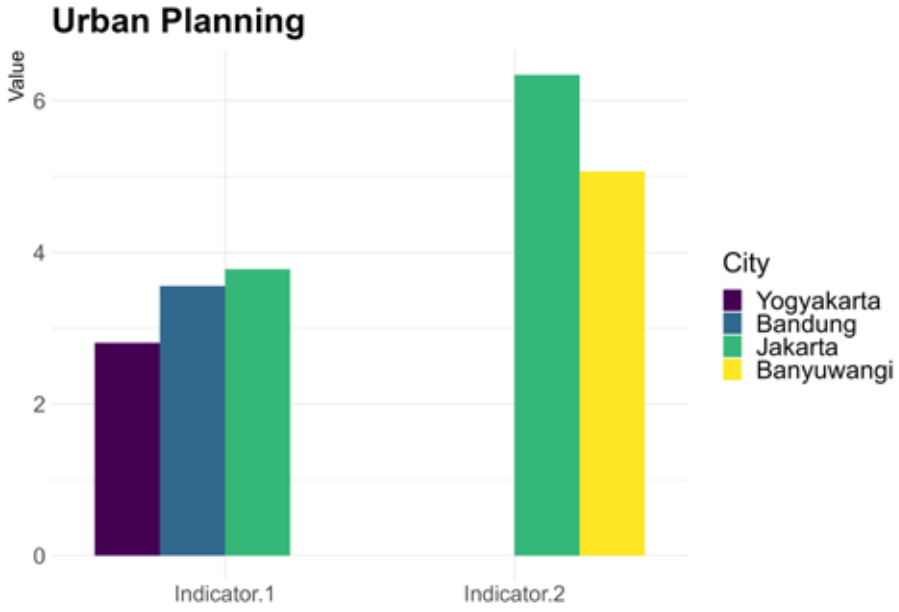

Figure 9. The urban planning sector values.

In this urban planning sector, posted from Indicator 1, Jakarta and Bandung lead among four other cities. The number of submitted building permits through an electric collection

system in Jakarta and Bandung is more than 3600 permits. Dissimilar from Indicator 1, in Indicator 2, Jakarta and Banyuwangi are higher up than other cities, but data was unavailable for Yogyakarta and Bandung.

Water

Water indicator assessments have been carried out for the cities based on the scaling values of the original values. It aims to present several indicator values that have different units. The water sector in SNI ISO 37122 contributes to pandemic control and prevention, being the first indicator of the city's water distribution network monitored by smart water and the second indicator of buildings in the city with smart water meters. Banyuwangi has the highest rate in the water sector of the four cities. Smart water systems have been implemented in many areas, facilities, and buildings in Banyuwangi.

Overall Scores

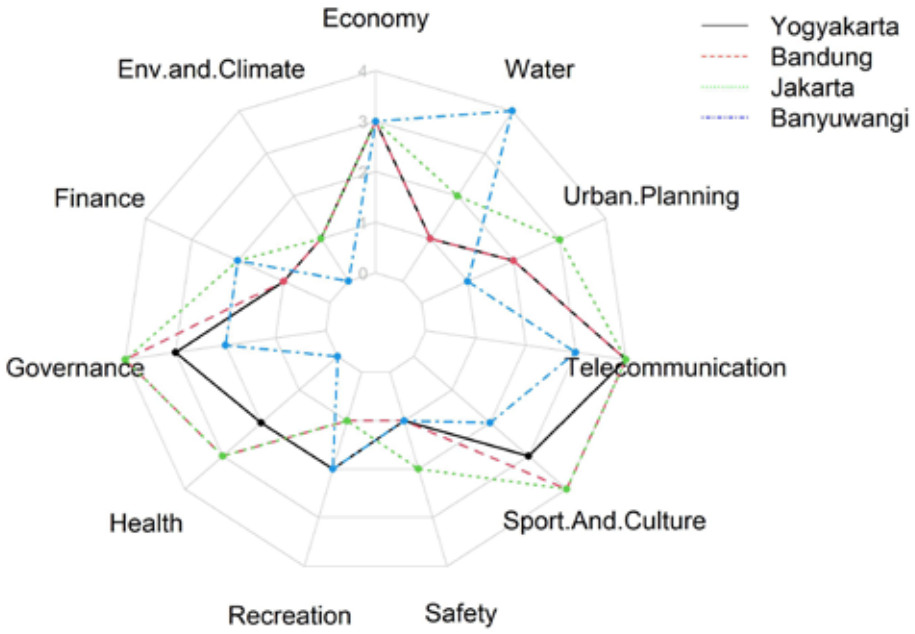

Figure 10. Overall sector scores.

Based on each sector scoring of observed cities, the cities with the best implementation in all indicators and sectors included in SNI ISO 37122 standard are Jakarta and then followed by Bandung, Yogyakarta, and lastly Banyuwangi. Jakarta leads in almost every sector. This was not surprising because Jakarta is the capital of Indonesia and the center of administration and business, so it is necessary for Jakarta to have satisfactory facilities because of society's needs and efficient integration. Sectors with a low score for Jakarta are the recreation sector and the environment and climate change sector. Both sectors need attention, consideration, improvement, and development by the stakeholders and regional government.

Bandung, Yogyakarta, and Banyuwangi are equivalent comparisons in which all cities have implemented smart city indicators well. The reason is that these three cities are placed on the same city level while Jakarta is a Capital Special Territory. Based on the three left cities, Bandung has higher scores of them. Bandung leads within sectors of the economy,

government, health, sports and culture, and telecommunications. Although Banyuwangi is the city that is entirely placed at the lowest rate, this city leads in the recreation and water sectors.

Relationship Between Scores and the Severity of Pandemic

During the linkage assessment between smart city indicator implementation and each city's ability to control the COVID-19 dispersion, the scoring process of each sector is linked to measuring the massive spread in a certain area. The linkage is going to be described descriptively based on available facts. According to the World Health Organization, two measures can be used to generate the proportion of infected individuals with a fatal outcome, which are mentioned as Infection Fatality Ratio (IFR) and Case Fatality Ratio (CFR).

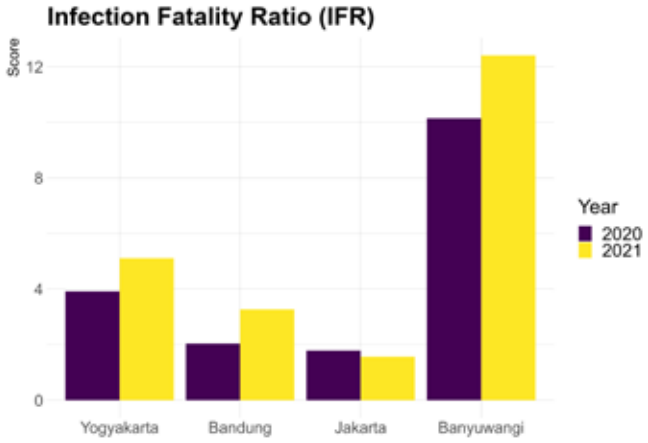

Figure 11. Infection Fatality Ratios.

The Infection Fatality Ratio (IFR) estimates the proportion of deaths among all infected individuals. The lower IFR value describes the virus spread, and its impact is controllable. The peak of the COVID-19 pandemic happened in 2020 and 2021. Each city has different IFR values. Jakarta has the lowest IFR value in 2020, with 1.79 percent, and in 2021, it comes with 1.57 percent. As additional information, during 2020-2021, the IFR value for Jakarta decreased while other cities' rates increased. Related to the other three cities, Bandung reached the lowest IFR score, and Banyuwangi achieved the highest IFR in 2021, which was 12.42 %.

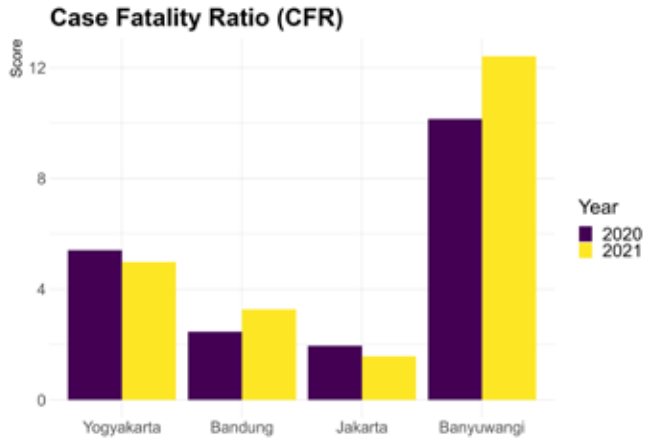

Figure 12. Case Fatality Ratios.

Figure 12 displays the case fatality ratio (CFR) for each city. Lower CFR values define impact, and COVID-19 spread is conductible. Like IFR, each city has a different CFR percentage. The lowest CFR value of 1.95 % appeared in Jakarta in 2020. Yogyakarta and Jakarta have decreased CFR values from 2020 to 2021. Despite the decreasing value, Yogyakarta has a higher CFR value than Bandung. Similar to the IFR percentage, Banyuwangi has the highest CFR value among the others.

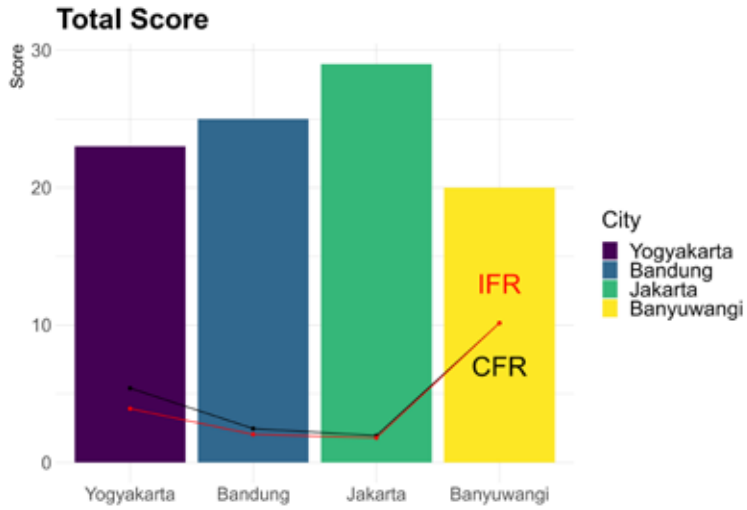

Figure 13. Relationship between IFR and CFR with a total score.

The comparison between IFR and CFR values in 2020 is presented in Figure 13, with total sector scores of assessments based on sector implementation and smart city indicators for each city. The IFR and CFR values, along with the scores of each city, are inversely proportional. A city whose highest score turns out to have low IFR and CFR values; otherwise, the city with the lowest score has both high IFR and CFR values. Based on the smart city indicator assessment, Jakarta mostly leads, but it has low values for both IFR and CFR, besides Banyuwangi, which is the city with the lowest score that has high IFR and CFR values. Hence, this can be concluded that based on available facts and existing primary data, every city that implements all smart city indicators tends to have the ability to prevent and control COVID-19 dispersion better than the city that does not implement the indicators. This can be concluded that every smart city indicator which is selected from preliminary research by Tampubolon et al. (2021) contributes to and has an important role during the COVID-19 pandemic. It is expected that this research will yield a useful discovery that can be utilized as a reference and evidence for further improvement, development, and consideration in Indonesia and other countries.

Discussion

The emergence of the COVID-19 pandemic has significantly changed the pattern of life. In addition to the loss of life, this pandemic has had a negative impact on the economy and social problems. The footprint of the pandemic created one of the biggest economic crises in modern history, a period of significant recession. The world is questioning how to avoid the next pandemic, perhaps worse. An important element for predicting, detecting, and responding to pandemics is data. Increasing data sources should be pursued by every city government. Initiatives are needed to create the smart city of the future. The government plays a major role in this process, particularly in making regulations and budget

allocations to support the program. Solutions for smart city development are more robust, proactive, and integrated. Large urban centers are naturally prone to infectious diseases. In general, cities that are more collaborative and integrated are better equipped to manage a pandemic than those that are not. Jakarta, as an example, has implemented a smart city indicator and has been shown to have the lowest pandemic severity.

An example of an initiative during the pandemic has crowned Jakarta as a smart city that is successful in predicting, detecting, and tackling pandemics through a digitalization platform called JAKI. By the end of 2021, more than two million Jakarta residents have downloaded JAKI. One of the features of JAKI, being a star, is the reporting of new cases and registration of COVID-19 vaccinations. Several achievements were won by Jakarta Smart City for the JAKI application in the e-Government category at the World Summit on the Information Society Prizes 2021. Another award was obtained from International Data Corporation Indonesia, winning in the Best in Future Digital Innovation category. In addition, JAKI also won a gold medal in the Public Sector category at the ASEAN ICT Awards organized by ASEAN. JAKI grows and develops with the latest features, making it easier for the people of Jakarta to meet their daily needs, especially during the COVID-19 pandemic. Overall, Jakarta has adopted six smart city categories, namely smart living, smart mobility, smart governance, smart environment, smart economy, and smart people (Syalianda & Kusumastuti, 2021).

The three cities in this study are still being developed. Bandung Smart City has been started since 2013; various initiatives have been carried out in implementing smart cities, such as the Bandung Command Center, Online Community Complaints and Aspirations Service, Single Number Emergency Call 112, Bandung Panic Button and Bandung Planning Gallery (Arfiansyah & Han, 2020). Meanwhile, Yogyakarta and Banyuwangi are still developing towards smart cities. The development of the smart city of Yogyakarta has established partnerships with related stakeholders. Currently, the City Governments of Yogyakarta and Banyuwangi are finalizing a roadmap for smart city development (Faidat & Khozin, 2018). The City of Banyuwangi has developed the Smart Village concept with a focus on developing rural areas to solve the problem chain. The smart village model is divided into 6 dimensions, namely 1) Governance, (2) Technology, (3) Resources, (4) Village Service, (5) Living, and (6) Tourism (Aziiza & Susanto, 2020).

Based on the overall score for each sector, Jakarta has the highest overall score compared to other cities, namely Yogyakarta, Bandung, and Banyuwangi. Jakarta, as the nation's capital, has easy access to health infrastructure and resources. Jakarta has more health facilities, including hospitals and other health centers, than other cities. Good health infrastructure can support greater treatment and testing capacity. As the country's economic center, Jakarta also has better access to resources, including medical equipment, medicines, and needed medical personnel. This is confirmed by Jakarta's IFR value, which has the lowest value compared to other cities. The IFR value refers to the proportion of deaths among people infected with COVID-19. The lower the IFR value, the lower the death rate caused by infection. The IFR value depends on various factors, including the quality of the healthcare system and success in detecting and reporting cases. This is supported by Jakarta's ability to implement various indicators that support smart cities. After Jakarta, the other lowest

IFR value is Bandung, followed by Yogyakarta and Banyuwangi. If we look at the CFR value, Jakarta also has a lower CFR value than other cities. The CFR value provides an idea of the death rate relative to the number of confirmed cases. The application of smart city indicators during the pandemic also has an important role, such as a system for monitoring and tracking positive cases, public health monitoring, telemedicine, and remote consultations that utilize advanced technology during the pandemic.

This research contains evidence of smart city implementation policies controlling the spread of the pandemic. The research results can be used as a basis for developing or improving policies related to the implementation of smart city standards in other cities. The application of smart cities can provide innovative and efficient solutions to face the challenges faced during health crisis situations.

Conclusion

Based on expert judgment and other analyses that were utilized in previous research, which concludes that through nineteen sectors in SNI ISO 37122, there are eleven sectors that are contributing to restricting the COVID-19 dispersion. The indicators in SNI ISO 37122 are supposed to influence the implementation of health protocols during the pandemic. This research contains evidence of smart city programs that are implemented in four cities of Indonesia, namely Yogyakarta, Bandung, Jakarta, and Banyuwangi; during the COVID-19 pandemic, it has controlled and prevented the COVID-19 spread. Each city has different superior indicators and seeks to build instruments or tools based on these indicators in an effort to realize the implementation of Smart City standards. This research yields much evidence related to the existence of a linkage that is a concern in smart city indicators that affect the COVID-19 spread limitation in Indonesia. Jakarta is one of the leading cities that has implemented the smart city indicators and has the lowest pandemic ferocity, which has proofed by its low IFR and CFR values. At the same time, for another three cities, Bandung leads among the other two cities in implementing the smart city indicators, followed by Yogyakarta and Banyuwangi. This measurement of pandemic ferocity is contradictory because Bandung has a low value for both IFR and CFR; meanwhile, Banyuwangi has the highest value for IFR and CFR. This research might be a guide for city management and the policy arrangement for selected cities or other cities. Nevertheless, it is important while applying these indicators might need responsibility to fulfill the assessment correctly and utilize the exact sources. Finally, it is needed to be thoughtful while using the consideration without the information that is not presented in the standard document. The lack of data on some indicators and the greater number of cities involved in this research provides more information and valuable insights for future policy development.

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