



Article

The Use of ICT-Based Applications to Support the Implementation of Smart Cities during the COVID-19 Pandemic in Indonesia

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Abstract: The COVID-19 pandemic has resulted in compulsion and encouragement of actions that have enabled changes to occur globally that have then been adapted to current conditions. For their highly dense populations, it is difficult to control the spread of the virus in cities. As a result, activities that draw large crowds together so that people can access public services are inevitable. Several cities that have been declared as smart cities in Indonesia have made a breakthrough by making use of information and communication technology (ICT)-based applications. This can be of great help for societies during pandemics. ICT has been able to help citizens perform various activities from home with the help of applications. This study aims to identify various applications that support the implementation of the concept of a smart city. This applies particularly to those applications that are based on ICT that can tackle the unique conditions of the COVID-19 pandemic and make recommendations regarding future developments. The data collected for this study were analyzed using secondary sources obtained from various clusters of literature, the internet, and social media. In addition, primary data was gathered from discussion forums. This paper employs a qualitative approach with qualitative descriptive data analysis techniques and hierarchical cluster analysis. Qualitative descriptive analysis was utilized to explore the conditions of smart cities, the regional conditions of the pandemic, and smart city applications more generally. The results show that during the COVID-19 pandemic, cities and regions, including the 100 smart cities in Indonesia, have developed many innovative solutions through ICT-based applications that can help people maintain an active social life and access public services. In the future, when everything is allegedly back to normal, cities need to implement the use of various ICT-based applications to increase efficiency in their planning and management. Therefore, it has become increasingly necessary to improve people's digital literacy and to develop a type of ICT infrastructure that enables more people to access the internet.

Keywords: applications; public services; smart city; ICT; infrastructure; internet; COVID-19; pandemic



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1. Introduction

The COVID-19 pandemic has impacted various regions on a global scale. Not only has it affected countries in Asia, such as China, where the COVID-19 outbreak began, and Indonesia, but it has also had a profound effect on countries in Europe and the Americas. Indeed, various countries have been locked down to limit the movement of their people entering and leaving the country to minimize the risk of transmission.

Keeping physical distance from one another and staying at home are pivotal ways to limit the spread of the virus [1]. Yet, people also need to participate in societal activities that all traditionally require leaving home. Since the emergence of COVID-19, the use of

mobile applications has been increasing, for so many people have had to stay at home for long periods of time [2]. The applications can help people access various types of public services. During the pandemic, the use of mobile applications in Indonesia increased by 25% in the third quarter of 2020 from the fourth quarter of 2019 [3]. Cellular applications thereby present a unique opportunity to make functional and accessible connections [4]. Importantly, cellular phone applications have been regarded by the government and business enterprises as vital tools to connect with society [2]. As long as the pandemic continues in Indonesia, people spending time at home will depend on mobile applications to perform their daily activities and support their needs [5]. In addition, the use of applications has been helpful in accessing different public services.

The coronavirus pandemic has resulted in increased anxiety in society. Small and medium-sized enterprises (SMEs) have also been affected by the pandemic in the form of strict quarantine regulations [6]. The constant flow of information regarding the virus, which is not always based on accurate medical facts, has made people even more anxious. Thus, credible sources of data and information through a variety of channels are urgently needed [7]. By making use of modern technology, information on coronavirus and its spread can be fast and accurately obtained [8]. Furthermore, the development of new technologies can offer innovative ways to provide additional income for SMEs [6]. Artificial intelligence (AI) and big data have enormous potential when managing COVID-19-related information in smart cities [9]. Therefore, it is necessary to have mobile applications that are both accessible and easy to use. Several cities in Indonesia that have applied the concept of a smart city have provided their residents with mobile applications. The function of these applications is not only to access information but also to support activities such as working, shopping, and studying. In addition, the applications can be used to remotely access public services which are provided by the government to help mitigate the spread of the virus [10]. People have started to use ICT-based applications to adapt to global changes and challenges regarding their life, work, and socialization [11].

This study aims to identify various applications that support the implementation of the concept of a smart city. This applies particularly to those applications that are based on ICT that can tackle the unique conditions of the pandemic and make recommendations for future developments. Much of the current debate centers on the pandemic with reference to the application of ideas and insights into smart technology in the field of urban planning and design [12]. For this reason, our aim has been to critically examine the use of mobile applications that support the implementation of smart city concepts in Indonesia during the pandemic and their development needs for cities of the future. In so doing, this study also makes it possible to compare Indonesia with other countries. Our research can be further used to provide relevant examples that can be replicated in other countries.

2. Materials and Methods

These research results from a critical study of secondary data that consist of several smart cities and regencies in Indonesia. They were chosen as research objects based on innovations initiated by the country's government in dealing with the COVID-19 pandemic. They all became an object of investigation, for it was crucial to find out what kinds of applications were employed to support the implementation of smart cities, particularly the ones that have been used during a pandemic. These various applications were developed by each local government with different objectives that were then adapted to the specific conditions in dealing with problems that arose in their respective regions. Among them are aims related to the ease of access to public services, general system improvement, and dissemination of valid and actual information. In this paper, we first identify the uses of these various applications and then proceed to make recommendations for the future.

The data collected for this study were taken from secondary sources obtained from various clusters of literature, the internet, and social media. In addition, primary sources were gathered from different discussion forums. Overall, the collected data consist of various applications developed by each city/regency in an effort to solve the problems

initiated by the COVID-19 pandemic. In addition, data from various applications that support smart cities and information related to the pandemic in several other countries are also critically discussed as a further reference. The applications are then analyzed to evaluate whether they can be recommended for the future. This paper employs a qualitative approach with qualitative descriptive data analysis techniques and hierarchical cluster analysis. Qualitative descriptive analysis was utilized to explore the conditions of smart cities, the regional conditions of the COVID-19 pandemic, and smart city applications more generally. Meanwhile, hierarchical cluster analysis was used to typify 100 smart cities and regencies based on the characteristics of the spread of COVID-19, the availability of mobile applications to handle the pandemic, and internet penetration conditions.

The research method of using secondary data analysis certainly has weaknesses in terms of its lack of depth in revealing the reasons why a particular smart city and district has chosen a specific application. Moreover, the method does not reveal the shortcomings and weaknesses of the applications in question and how extensively they are used today. These methodological limitations allow further research in this study field to take place by focusing on one or two applications and by investigating applications that are most widely used or have similarities with various smart cities and districts.

3. Smart City in Indonesia

The concept of a smart city is defined here as an urban development connecting society, information, and city elements based on renewed technology with the aim to establish a sustainable and green city with a competitive and innovative economy and to improve the quality of life as a whole [13]. In addition, smart cities have become part of the development strategy that emphasizes investment in human capital, transportation, and ICT in creating more sustainable economic growth and improving the quality of social life [14]. Smart cities have also created a strong link between technology and services, decreasing human interaction to a minimum [15]. One of the impacts of using ICT is that the location of business activities, offices, and residences is further decentralized to suburban or even rural areas [16] so that this enables new centers for public services to grow. This is possible to occur, for people can make use of ICT to facilitate their daily activities that can be done online on smart ware or on real-time platforms. This way, multiplier effects can be triggered, particularly related to economic and educational sectors. Therefore, the existence of smart cities helps solve various urban problems by making use of ICT connected to urban infrastructure [17]. While the nature of public space changes with the advent of technology, it develops more dynamically with invisible social interaction [18]. Smart cities, in turn, can improve the quality of life of the people living in them by contributing to more sustainable development [19].

The implementation of smart cities in our daily lives can be done through six interconnected components: smart governance (public participation), smart human capital (people), smart environment (natural resources), smart living (quality of life), and smart economy (economic competitiveness) [20,21]. In Indonesia, the implementation of smart cities has been accelerated by the government through the program called Toward 100 Indonesian Smart Cities conducted by the Ministry of Communication and Information. Indeed, this program has been able to help cities and regencies plan each smart city through the making of a master plan that covers the vision, action plan, and road map of a smart city, which could help direct the program of future smart cities. In addition, in planning a smart city, it is also necessary to pay attention to the availability of relevant structures, infrastructure, and suprastructure in each city and region, so that the goals of a smart city can be achieved [22]. The concept of a smart city is expected to make the city more livable and create a more sustainable community [23]. Globally speaking, smart city projects are a significant challenge to urban development [24]. At the moment, there have been 100 Indonesian cities and regions that are committed to implementing the concept of a smart city through a renewed innovative approach based on the six dimensions of smart city, i.e., smart governance, smart economy, smart branding, smart society, smart living, and smart

environment. However, the six dimensions of smart cities mentioned are different from the previous ones which were sourced from other literature.

4. COVID-19 Pandemic in Indonesia

COVID-19 is an infectious respiratory disease whose symptoms are similar to influenza, such as a new and continuous cough, high fever, and a loss or change to your sense of smell or taste [25]. The initial spread of the virus took place in Wuhan, China. The first case, in turn, was reported on December 31, 2019. As of April 2020, it had spread globally and infected close to one million people [26]. According to the data released by the World Health Organization, there had been 153,954,491 recorded cases as of 5 May 2021, 3,221,052 of which ended in death [27]. COVID-19 comes with devastating effects regarding the region infected, especially in larger cities. For instance, in February 2020, it was reported that 34% of the French cases were located in Paris, 14.6% of the American cases in New York, 61% of the Canadian cases in Quebec, 70% of the Chilean cases in Santiago, and 25% of the Brazilian cases in Sao Paulo, as well as having the highest number of fatality cases among that state, often even more than twice the national average [28].

The spread of COVID-19 occurs when direct contact with the affected person occurs through his or her breathing, spreading sneeze droplets, and coughing close to other people [29]. Therefore, limiting physical activities and large crowd gatherings needs to be done to minimize the direct contact among people since they may potentially result in spreading the disease. Consequently, sectors that need direct contact among people experience losing their income because of the limitations on physical contact. As a result, social life habits have been changing as well.

Indonesia is one of the countries that has not been able to avoid the COVID-19 pandemic. The first case was confirmed on 27 February 2020, when two people visited the country [30]. Then, the cases have been increasing based on the data from the Ministry of Health of the Republic of Indonesia. The number of cases keeps increasing from time to time. The number of deaths resulting from the disease is recorded at 46,349 [31]. So far, the virus has spread to all 34 provinces, with a total number of 502 cities/regencies affected. Jakarta has 25.3% of the confirmed cases while 74.7% is spread across the 33 other provinces, especially West Java (16.5%), Central Java (11.3%), East Java (9.3%), East Kalimantan (4.2%), and South Sulawesi (4.0%), which are shown in Figure 1. To combat the issue, the Indonesian Government imposed a rule popularly abbreviated as PSBB (*Pembatasan Sosial Berskala Besar*/large-scale social distancing). For example, working from home was applied to office-based jobs. That way, how to perform work also changed, for it could now be done online from home. Various innovative platforms were then launched regarding smart cities by making use of digital applications to face the pandemic, aiming to make it easier for people to perform their daily activities. These digital applications are useful for supporting work from home so that the continuity of administration, education, economy, and culture can be maintained.

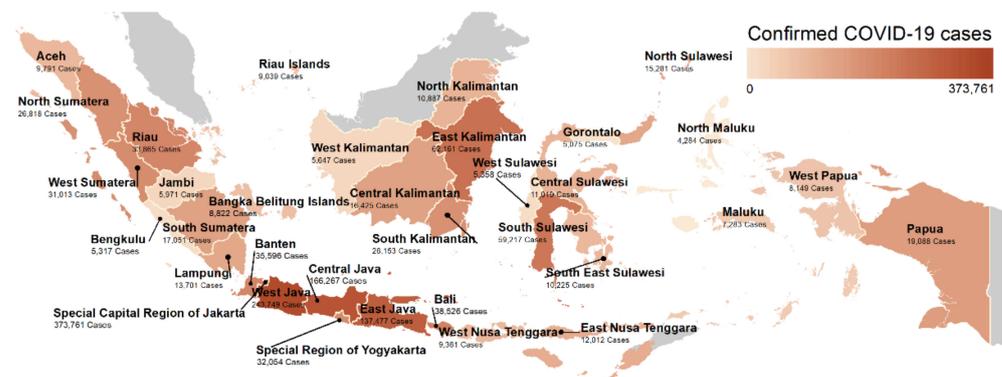


Figure 1. Cumulative cases of COVID-19 in 34 provinces. Source: [32] accessed on 23 March 2021.

5. Applications Supporting the Implementation of Smart Cities in Other Countries

The situation in Indonesia regarding the implementation of smart cities shows that cities and districts that have declared themselves as smart cities have a variety of applications. The existence of public services applications has been very helpful for the community since it has been more effective and efficient in terms of speed and ease of access. In addition, it has been more practical and economical, for it reduces movement and can be accessed from home.

In one of the articles found in the book COVID-19 Apps, there is a comprehensive analysis of the use of mobile applications in the fight against the pandemic. In total, there are 108 applications of COVID-19 in 73 countries, which can be divided into five groups. They are: informational apps, self-assessment/medical reporting apps, contact tracing apps, multipurpose apps, and other apps related to the virus [2]. This could act as an inspiration to group applications in different cities and regencies in Indonesia. The following shows some examples of the use of these applications in several countries that can be seen in Table 1. The table provides examples for each type of application group.

Table 1. Examples of COVID-19 applications in different countries.

Country	Use of Applications	Group of Apps	Field of Information Handled
Brazil— Coronavirus— SUS	The Brazilian Ministry of Health launched this app to raise awareness among the population about the outbreak. Information on how to act, where the nearby health units are or what to do in case of contracting COVID-19 are some examples of the information displayed.	Informational apps	Information of Health
Belgium— moveUP App	This app can facilitate the initial assessment and follow-up of suspected or diagnosed COVID-19 patients. The app is free of charge and available for people who think they have symptoms of COVID-19 and need to contact their General Practitioner or for doctors who want to register so that patients can connect with them.	Self-assessment/ Medical reporting apps	Application for initial assessment and follow-up of patients diagnosed with COVID-19
Brazil— DESVIRALIZE	This is an online platform offering local, real-time monitoring of the evolution of COVID-19 (maps and statistics). However, the app also shows the symptoms of the people around users and of those who are part of their network. To have access to the information, it is necessary to provide a telephone number.	Contact tracing apps	Local monitoring application for COVID-19 through maps and statistics

Table 1. Cont.

Country	Use of Applications	Group of Apps	Field of Information Handled
Nepal—Kathmandu Metropolitan City (KMC)	Developed jointly by NREN, Insol, iClick, PHECT-Nepal, NADEM, IDS, and ICT4D, an app has been launched that allows self-assessment for Kathmandu Metropolitan City (KMC). However, the app can also be used for people outside of KMC. The system provides a dashboard for health workers to monitor patients under self-quarantine. The app also has a surveillance feature: the GIS-based mapping tracks people in quarantine and does location-based strategic planning.	Multipurpose apps	Self-quarantine monitoring and GIS-based mapping application for people in quarantine.
South Korea—The Corona 100 m (Co100)	This application informs users about the past movements of individuals who are confirmed positive for COVID-19. Users will hear an alarm when they are within 100 m of the location that has been visited by individuals who have tested positive for COVID-19.	Contact tracing apps	Application to track location traces by individuals who are confirmed positive for COVID-19.

Source: [33,34].

Other relevant case studies in this context include Singapore and Japan. Both countries have integrated the use of ICT into their public programs to lower the spread of the virus. The success in handling COVID-19 by integrating the use of ICT with public programs in both countries is a good example and will be discussed related to the implementation of applications in handling the pandemic. The first case in Singapore was recorded on 23 January 2020. The number of cases then rose to an average of 6126 per one million people, which was higher than that in the United States of America (USA), Italy, and Brazil, each of which recorded the numbers of 5621, 3857, and 2492 per one million people, respectively. However, that number is balanced with the low number of deaths, comprising of four deaths per one million people in Singapore, which is much lower when compared to that in the USA, Italy, and Brazil, each of which recorded the numbers of 323, 554, and 141 per one million people, respectively [35].

Singapore took immediate action to prevent an outbreak by learning from its SARS mitigation of the past, which was classified into in-between learning, trial-and-error learning, and contingency learning phases. After the outbreak reached untraceable and secondary local transmission, the government decided to use a “circuit breaker”, meaning that its citizens were obliged to do their activities at or from home and closed all borders to and from Singapore [36]. In effect, the “circuit breaker” became a pillar for Singapore’s mitigation effort with intensive contact tracing and strict quarantine rules [37]. Then, the government introduced several digital applications to help prevent and solve COVID-19. All activity of its citizens, both inside and outside the country, was monitored based on the development of the pandemic. This data was taken from the Singaporean Ministry of Health. Other smart city applications, which have had a significant role in the pandemic in the country and which are developed by the Government of Singapore, are “TraceTogether” and “SafeEntry”. “TraceTogether” could trace individuals who are within 2 m of infected individuals accurately by using its effective Bluetooth signals. “SafeEntry”, in turn, must be used as a digital check in and out scanner to record the departure and arrival time by

each individual so that it could help identify the exact time and identity of the person, especially to manage physical distancing [38].

Another innovation by the Government of Singapore is “FluGoWhere”. It contains information regarding the closest health clinics, especially the ones providing examination for respiratory complaints, as explained in one of the following sources:

Information found in “FluGoWhere” is presented based on the location and shows which clinics give service subsidy to patients so that health examination can be taken easily and quickly. In addition, there is also an innovation called “TraceTogether”. It records the travel of society through the signal of telephone Bluetooth whose data are storage for 21 days. The recorded data, with the permission of the patient, can be used by the Ministry of Health to trace contacts that a COVID-19 patient has made before so that the spread track can be traced (Source: [39]).

As for Japan, to prevent the spread of the virus, the Japanese government introduced something called the “Japan Model”. What the Japanese government did eventually resulted in low death rates: fewer than 1000 as of 24 June 2020 [40]. While most countries experienced high increases in the number of affected people and deaths, Japan was able to limit the first outbreak. As of 7 June 2020, Japan had reported more than 17,000 cases, of which 910 resulted in death [41]. Below is the description of the use of applications there:

The Japanese government has launched a tracing application of COVID-19. The application relies on the platform of descriptive notice which is developed in cooperation with Google. The tracing application uses Bluetooth to help determine whether the user has made a contact with someone receiving positive test of COVID-19. Even though the list of application store only says “COVID-19 Contact App,” Japanese call it “COCOA”, standing for COVID-19 Application-Confirming Application. “COCOA” does not store personal information such as location, telephone number, and request as they are in line with the tracing platform of Apple and Google. (Source: [42])

6. Results

6.1. Application Innovation Supporting Smart Cities in Indonesia

To only focus on applications that support smart cities to tackle COVID-19, grouping was carried out on applications from various countries, as well as from the various applications of smart cities and regencies in Indonesia. These applications were then grouped based on their purpose and function, such as informational apps, contact tracing apps, digital economy apps, online learning apps, health care apps, government service administration apps, tourism guide apps, and multipurpose apps. This grouping helped us identify and explore the completeness and suitability of each application as part of the ICT infrastructure at each location, i.e., cities and regencies, in dealing with the pandemic.

In this part of the paper, technological innovations for smart city applications found in several Indonesian cities and regencies are presented. They comprise megacities, such as Jakarta (Capital Special Territory of Jakarta) and Surabaya (East Java), and big cities such as Denpasar (Bali), Bandung (West Java), Makassar (South Sulawesi), Semarang (Central Java), and Surakarta (Central Java). Several cities and regencies that are included in the 100 Smart City movement in Indonesia are shown in Figure 2. The list of applications launched by each city and regency, in turn, is found in Table 2 below.

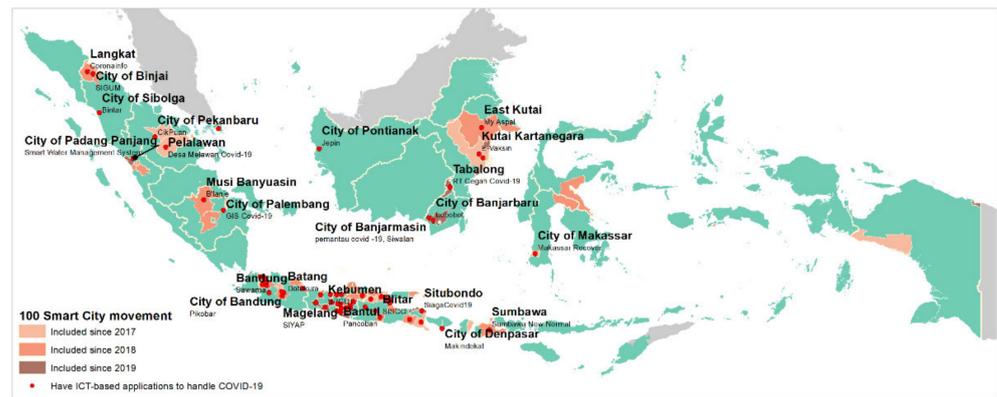


Figure 2. Distribution map of cities and regencies that are included in the 100 Smart City movement in Indonesia. Source: [43].

Table 2. List of applications used to handle COVID-19 in several Indonesian smart cities/regencies.

City/Regency	Smart City Application	Field Handled	Group of Apps
City of Jakarta—Capital Special territory of Jakarta	Jaki	Information related to the spread of COVID-19	Informational Apps
City of South Tangerang	Mata Tangsel	Tracing and examining people who have indicated COVID-19 infection	Contact Tracing Apps
City of Tangerang	Sigacor, Tangerang Live	Data collection and COVID-19 cases, data collection on social assistance recipients; public service application to support e-government	Informational Apps
Regency of Tangerang	SIBAMAS	Data collection of capital assistance for MSMEs and communities affected by layoffs due to the pandemic	Informational Apps
City of Denpasar—Bali	Makindekat, TemuWA, and LenteraBelajar	Populist Economy and Educational Services	Economy Apps And Education Apps
City of Bandung—West Java	PIKOBAR, Pasar Pintar	Information related to COVID-19 and social aid; Fulfillment of the need for food	Informational Apps
City of Semarang—Central Java	Ambulance Hebat	Health service	Health Apps
City of Makassar—South Sulawesi	Baruga Sikola	Educational Service	Education Apps
City of Surabaya—East Java	SSW Mobile, PPDB SD Surabaya, PPDB SMP Surabaya	Licensing and educational service	Education Apps

Table 2. Cont.

City/Regency	Smart City Application	Field Handled	Group of Apps
Regency of Kebumen—Central Java	SPGDT (Sistem Penanggulangan Gawat Darurat Terpadu/Integrated Emergency-Tackling System), e-BPHTB, Pancen Maen, and iKebumen.	Information on health, population, and economy	Informational Apps
Regency of Klaten—Central Java	Matur Dokter Klaten, SIPON KEDUTEN.	health and population service	Health Apps
City of Surakarta—Central Java	Dukcapil dalam Genggaman	Population service	Population Apps
Regency of Kendal—Central Java	Yankes Online, SIAPP, Poskamling Pintar, and application of Pasar Pintar	Living environment, investment, administration management, education, health, income of society, poverty, gender responsive, youth awareness, infrastructure, and populist economy	Multipurpose Apps
Regency of Kutai Timur—East Kalimantan	Applications of MYASPAL, GONDES, ekojek, angkasa, Goetam, and online meeting Saling Keruani, Inovasi SIAP Lapor, Teman For Us, and	Information on health and populist economy	Informational Apps
Regency of Empat Lawang—South Sumatra	Jemput Bola Dokumen Administrasi Kependudukan (JEBOL DAKU)	Information on population and public services	Informational Apps
Regency of Kulonprogo	Jendelaku, Lacakku	Public services, government staffing, and information on COVID-19 suspected	Population Apps
City of Yogyakarta	Jogja Pass	Data collection and verification on visitors and tourism activities	Tourism Apps
Regency of Bantul	Pancoban	Monitoring the spread of COVID-19	Informational Apps
Regency of Sleman	Sleman Smart Apps, CovidTracer	Integrated information system to support smart city implementation, COVID-19 information, contact tracing application	Informational Apps
City of Sukabumi	Candil, Uduan Online, Bageur Box	Digital library, monitoring and distribution of social assistance, marketing of MSMEs products	Multipurpose Apps
City of Cimahi	Cimahi Smart City	E-government and public services	Government Apps

Table 2. *Cont.*

City/Regency	Smart City Application	Field Handled	Group of Apps
City of Depok	Depok Single Window, Picodep	E-government, public services, COVID-19 alert village, monitoring of suspects and confirmed cases	Government Apps
City of Cirebon	Jaga Warga, SSO DKIS	Monitoring of confirmed COVID-19 cases at the neighborhood level and public services	Informational Apps
City of Bogor	Jejak, SiBadra	Data collection and monitoring of urban mobility and public complaint	Informational Apps
Regency of Bandung	Sawarna	Monitoring the progress of handling pandemic	Informational Apps
Regency of Bogor	Temam Sehat	Data collection and monitoring on contact tracing	Contact Tracing Apps
Regency of Sragen	Pasar Online, Go-Shop, dan Pasarmu	Online shopping	Shopping Apps
Regency of Blora	Dolan Blora	Travel guide on new normal	Tourism Apps
Regency of Batang	Dotukura	Online shopping	Shopping Apps
Regency of Pemalang	FormPendatang	Data collection of newcomers and entry permit	Population Apps
City of Magelang	iMagelang, Magelang Cerdas	Digital library and health services	Health Apps
Regency of Wonosobo	Jelajah Wonosobo	Travel guide on the new normal	Tourism Apps
Regency of Sukoharjo	SI-COVID Sukoharjo	Monitoring of COVID-19 pandemic	Informational Apps
Regency of Magelang	SIYAP	Disaster management services system	Disaster Apps
Regency of Banyumas	Vaberaya, Jiwong Jiga	Data collection and monitoring of vulnerable population	Informational Apps
Regency of Bojonegoro	BOSE, SIBANTU	Monitoring of suspects, confirmed cases, and social assistance	Informational Apps
Regency of Sidoarjo	Delta Trisula	Monitoring of COVID-19 patients	Informational Apps
City of Madiun	MaSMaS, e-BundaHebat, SIST-BRO	Health facility services	Health Apps
Regency of Gresik	Poedak	Online system of population administration	Population Apps
Regency of Lamongan	POL, Jago Sinau	Online shopping and online learning	Disaster Apps
Regency of Situbondo	SiagaCovid19	Official information on the response to the COVID-19 pandemic	Informational Apps
City of Kediri	Sigap	Mapping of potential crowds during Micro PPKM	Informational Apps

Table 2. *Cont.*

City/Regency	Smart City Application	Field Handled	Group of Apps
Regency of Blitar	SISCO	Real-time COVID-19 graphic and information system	Informational Apps
Regency of Banyuwangi	Smart Kampung, Banyuwangi Tourism	Daily reporting of COVID-19 cases from all of health facilities; database of health protocol certifications for tourism sector businesses	Informational Apps
Regency of Jember	SoeMAd, Lahbako dan SIP	COVID-19 early/self-diagnosis; population administration services	Population Apps
City of Pontianak	Jepin	COVID-19 pandemic information	Informational Apps
City of Banjarbaru	Bobobot	The spread of COVID-19, online CCTV, and free hotspot locations	Informational Apps
City of Banjarmasin	Pemantau COVID-19, Siwalan	Contact tracing and registration for COVID-19 portable testing	Contact Tracing Apps
Regency of Tabalong	RT Cegah COVID-19	Screening and COVID-19 daily case report	Informational Apps
City of Samarinda	Behambinan	Online shopping for Ramadan and Eid needs during the pandemic	Shopping Apps
Regency of Kutai Kartanegara	E-Vaksin	Data validation on COVID-19 vaccine recipients	Health Apps
City of Tanjung Pinang	Tanjak	Information about the spread of COVID-19 pandemic, health, education, and population administration services	Multipurpose Apps
Regency of Sumbawa	Sumbawa New Normal	COVID-19 response/handling action	Informational Apps
City of Pekanbaru	CikPuan	Contact tracing data and monitoring	Contact Tracing Apps
Regency of Pelalawan	Desa Melawan COVID-19	The spread of COVID-19	Informational Apps
City of Padang Panjang	Smart Water Management System	Real-time water quality, water pressure, temperature, vibration, customer meter, and leakage	Environmental Apps
Regency of Musi Banyuasin	B'lanje	Online shopping for vegetables and basic necessities	Shopping Apps
City of Palembang	GIS COVID-19	Geospatial information about the spread of the pandemic	Informational Apps
City of Sibolga	Bintar	Courier service for MSMEs products	Service Apps
Regency of Langkat	Coronainfo	Monitoring and countermeasures to the pandemic	Informational Apps
City of Binjai	SIGUM	Online learning/class system	Education Apps

Source: [44–54], Result of discussion, and Researcher’s Data Processing (2020).

The cities and regencies listed in Table 2 have implemented smart city and various ICT-based applications as an effort to minimize the spread of COVID-19. Smart cities in Indonesia are encouraged to implement applications to support programs and activities in reference to all elements of smart cities. Every year, cities and regencies that are included in the 100 Smart City movements in Indonesia are being evaluated. In building or implementing an application, there are two factors that must be considered to achieve the goals smoothly. The first is the user’s expectation. The second is the usage facility factor, which is more important [55].

Several cities could be considered as having been able to handle the pandemic better than others, although the province of those cities could have a high cumulative case number, such as in the case of Jakarta, West Java, East Java, Central Java, Bali, South Sulawesi, East Kalimantan, and South Sumatra (see Figure 3).

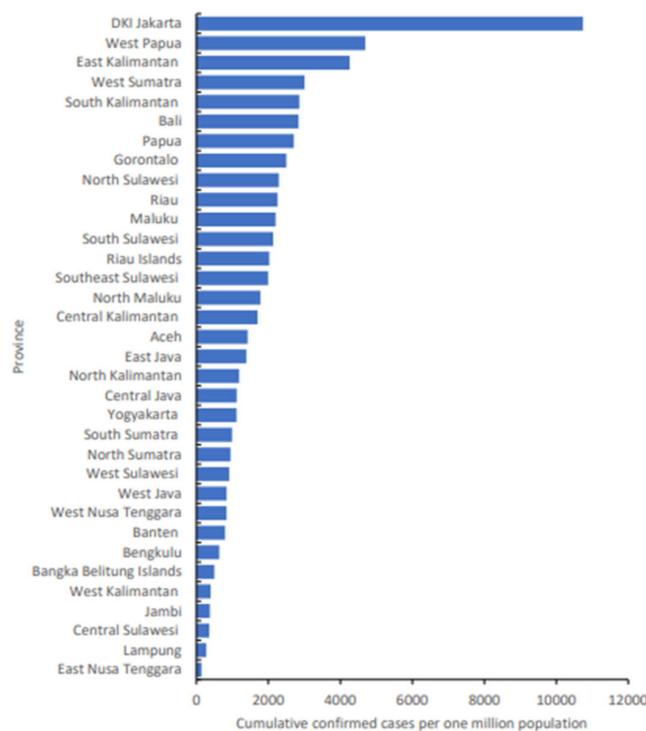


Figure 3. Daily number and cumulative cases of COVID-19 in Indonesia as of 14 November 2020, Source: [27].

As for handling the pandemic, some Indonesian cities have become pioneers for other regions in the country. For example, Jakarta has put PSBB. In addition, the capital city has also become a reference to other regions in the country on how to handle and implement risk reduction of the virus.

There are also several other pilot cities. While Denpasar City has maximized the role of smart cities and innovation (which have reduced the number of cases), Bandung has provided similar adaptive solutions [48]. Makassar has provided the best innovations in terms of potentially becoming the first city to collaborate with the Japan Association for Smart Cities in ASEAN (JASCA) [56]. The Surakarta City Government, in turn, is in the top six of the Innovative Regional Government Awards for the Innovative City Government category. Surakarta has excelled in digital infrastructure in terms of internet services, hardware, integrated systems, and data automation skills, as well as in policy recommendations and policies on prevention, control, and recovery from COVID-19 [57]. Surabaya City won the Indonesian Smart City Index award 2018, organized by “*Harian Kompas*,” in the category of Metropolitan City with the highest score. Semarang City ranks second in the Metropolitan City category. In the Big City category, Denpasar came first

while Surakarta came second [58]. The following are more specific examples of applications that were implemented in several big cities.

6.1.1. City of Jakarta—DKI (Daerah Khusus Ibukota/Capital Special Territory) Jakarta

Jakarta is the capital of the Republic of Indonesia. It has regional dominance in the sectors of trade, services, and industry. These three sectors are so large that they influence both the regional and national economies. This is what attracts many people to come to Jakarta to find jobs, which, in turn, makes the city densely populated. The City Government of Jakarta has developed an application called “Jaki” with the feature of “Jejak” (Track) to control the spread of COVID-19. The feature found in the application constitutes a collaborative project between Jakarta Smart City and the Cartenz Group. By making use of the feature Jejak (see Figure 4), it can be used to scrutinize individual movements through a QR code. At the same time, it can show the exact location of a COVID-19 patient for the last 14 days [44].

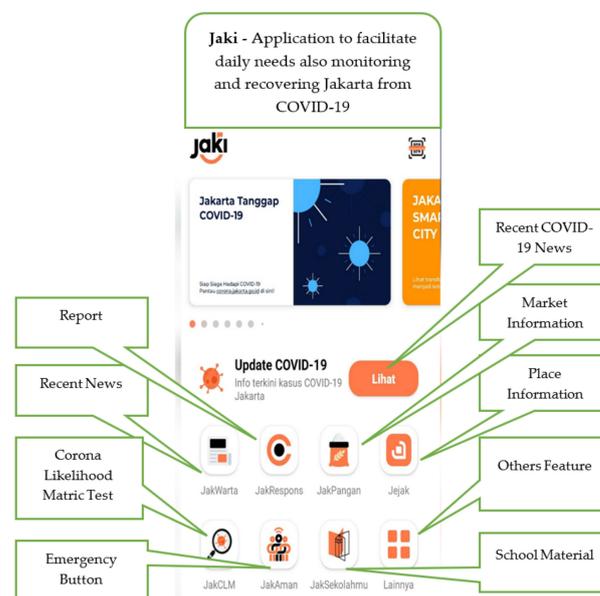


Figure 4. The appearance of the application “Jaki”. Source: [59].

6.1.2. City of Surabaya—East Java

The Surabaya City Government launched the “Surabaya Single Windows” (SSW) mobile application to facilitate the online licensing process in the city. In the SSW application, there is a menu regarding guidelines for using the application. On the home page, there are three menus: registration, monitoring, and contact us. In total, there are three kinds of registration: industry and trade, tourism, and population. In industry and trade, there are Trading Business Permit, Company Registration, Self-Service Shop, Business License, and Warehouse Registration Certificate. In the population, there are licensing, birth, and death certificates [54].

The Surabaya City Education Office provided an Android-based application to facilitate the registration of new students at the level of elementary school (SD) and junior high school (SMP) in 2020 due to the COVID-19 pandemic. The PPDB SD Surabaya application is for elementary schools, whereas the PPDB SMP Surabaya is for junior high schools. The features in the PPDB application are made easy to understand so that there are no difficulties when parents or prospective students access them [53].

6.1.3. City of Denpasar—Bali

The pandemic has had a profound effect on the economic conditions of many regions. Denpasar, the capital of the province of Bali, is one of the regions most affected by the pandemic. Denpasar, with its international tourism potential, cannot certainly be separated

from its economic activities. One of the efforts made by the Board for Creative Economy of the city was to develop an application called “Makindekat” (see Figure 5). The aim of the application was to facilitate shopping needs so that people do not have to leave their homes. The application can be used to do shopping at your nearest grocery store that is no more than five kilometers away. By making effective use of this application, large-scale social distancing becomes possible at the time of pandemics. At the same time, economic turnaround in the region and economic activities in the villages will occur to recover. In this type of business environment, shopping online can have competitive sustainable advantages [60]. This application is developed by the Board for Creative Economy in cooperation with the City Government of Denpasar. It is also used as a database of merchants in the city.



Figure 5. The appearance of the application “Makindekat”. Source: Researcher’s documentation, 17 August 2020.

Meanwhile, the application “TemuWA” was developed by the community of Denpasar to facilitate online buying and selling on the application WhatsApp. There have been at least 2000 users of the application from UMKM (*Usaha Mikro, Kecil, Menengah*/Micro, Small, Middle Enterprises) joining the group [46]. Regrettably, not all UMKM agents are technologically literate. Because of the sudden pandemic push, however, they have been forced to catch up with technological advances to widen their network. Nevertheless, younger UMKM agents have normally no trouble accessing e-commerce or the marketplace. Older agents, in turn, find it difficult to adapt to new technology as they experience many things for the first time. Therefore, the presence of the application will make it easy for the UMKM agents to get an opportunity to access e-commerce or the marketplace. The application is user-friendly.

Denpasar has also optimized the use of its application for public services, which can be accessed from home. More than 530,000 schools in Indonesia had to be closed in an effort to reduce the spread of COVID-19 [61]. The application Lentera Belajar was intended for students to help them understand school materials better. The application was accessible from home during the pandemic. It provides different school materials, exercises, examinations, and trial tests that can all be done online [47]. Thus, it is particularly helpful for those students who have to study from home.

6.1.4. City of Bandung-west Java

The City Government of Bandung also launched an application called “Pikobar” (see Figure 6) to tackle the COVID-19 pandemic. By using the application, the government is

able to recognize who is eligible to receive social aid. The application shows information on the social aid recipient and the source of funds [62]. It makes it easy for members of society to get transparency or make a fund claim for social aid when they find their names enlisted on the recipient list of social aid. In addition, “Pikobar” also includes information regarding the number of COVID-19 patients, map of location spread, and phone number in case of emergency, self-health checks, and complaints. In general, the application has been useful when trying to stay alert during the pandemic. Furthermore, it could also make people feel more secure, for they can trust the information available through the application. Moreover, there is another application called Pasar Pintar. The aim of the application is to facilitate shopping needs so that people do not have to leave their homes.

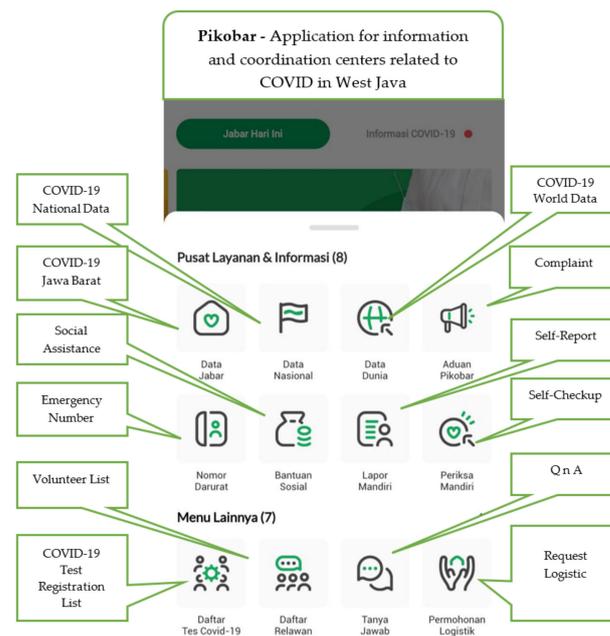


Figure 6. The application “Pikobar” in West Java. Source: [63] accessed on 17 August 2020.

6.1.5. City of Makassar-south Sulawesi

As a result of COVID-19, the City Government of Makassar has also been trying hard to make necessary innovations for the improvement of its teaching and learning processes, which have also been significantly affected by the pandemic. Teaching and learning are now fully conducted online to minimize the spread of the virus. The use of technology has a fundamental role to play in this. A relevant example is e-learning, which can aid electronic-based distance learning processes by utilizing a computer network, such as via WhatsApp, Telegram, and Zoom [64]. Yet, online teaching and learning processes are not always effective, for many students still find it quite difficult to understand new materials without a real teacher next to them. To respond to the changes and challenges in teaching and learning, the City Government of Makassar launched an application called “Baruga Sikola.” It can be used to support students in their study at home, especially regarding new materials and homework [65], the aim also being that students stay motivated and enthusiastic about their studies during the pandemic. “Baruga Sikola” is available on Google Play and is freely accessible from any smart phone.

6.1.6. City of Semarang-central Java

The City Government of Semarang has also launched “Ambulance Hebat,” which is a health service application that guarantees the needs of the community in terms of medical emergencies. It can be contacted via call centers 112 or 1500–132 anywhere and anytime, and as the spearhead of health services, they aim to get a quick response [49]. The

application will display ambulance request data according to the data received from the user application. The application is also equipped with a navigation map display [66].

6.1.7. City of Surakarta-central Java

The Office of Population and Civil Registration of Surakarta has launched the “Dukcapil Dalam Genggaman” application (see Figure 7) to facilitate its residents’ administration services [50]. Residents no longer need to queue and wait long times to get city’s administration services. “Dukcapil Dalam Genggaman” contains services for managing electronic identity cards, family cards, birth certificates, children’s identity cards, and death certificates [67]. The launch of this Android-based application is a new innovation for the Surakarta City Government to increase public awareness while making it easier to manage its population administration simultaneously [68]. This application can cut its users’ queuing times by about 30 percent and reduce the potential of brokering [69].

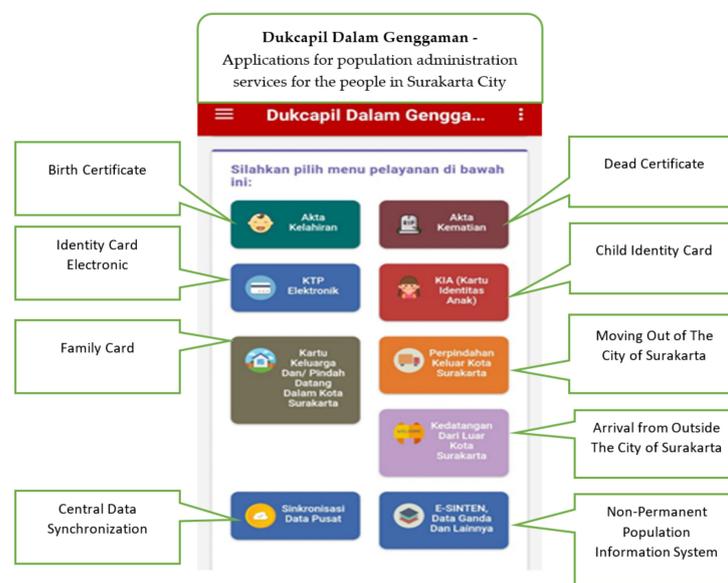


Figure 7. The “Dukcapil Dalam Genggaman” application. Source: Researcher’s documentation, 30 December 2020.

6.2. Internet Penetration in Indonesia

Internet penetration is the relationship between the number of internet users and population demographics in a particular area or region [70]. It goes without saying that the success of using applications to handle the COVID-19 pandemic as well as smart city implementation also depends on the internet penetration levels in each city or regency. Based on the results of a recent survey from the Indonesian Internet Service Providers’ Association (APJII), Indonesian internet penetration levels stood at 73.7% of the total population in 2020. The highest percentage of internet users as per total population is from the provinces in the islands of Sumatra and Sulawesi, such as West Sumatra (91.4%), Riau Islands Province (86.7%), and Southeast Sulawesi (87.1%) as shown in Figure 8. In the future, affordability regarding the internet needs to be improved as part of increasing ICT infrastructure.

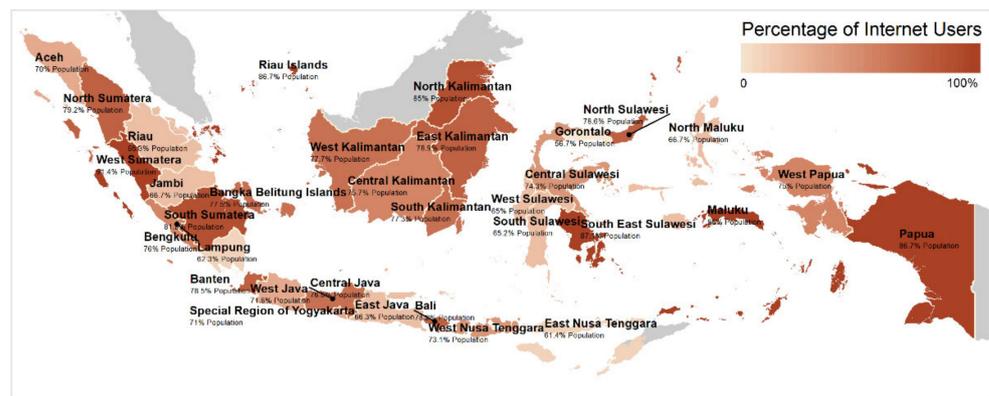


Figure 8. Distribution map of internet users as per total population in Indonesia in 2020. Source: [71].

6.3. Typology Analysis of Smart Cities in Indonesia

Cities and regencies that are included in the 100 Smart City movement in Indonesia can be classified according to the number of confirmed cases, the availability of a specific application to deal with the pandemic and the level of internet penetration. Hierarchical cluster analysis is used to find eighth different clusters based on different characteristics. Hierarchical clustering was chosen, for it has more in line with the characteristics of the used input data, such as small datasets (≤ 100), having variables containing categorical data, and the number of clusters that was not determined as input [72]. The results are shown in Table 3 and Figure 9. The important clusters to discuss further are the fifth, sixth, and seventh clusters. The seventh cluster does not yet have a single application that aims to deal with the pandemic, although it has a relatively high number of confirmed cases (12,370 cases on average), and it already has a good internet infrastructure. On top of that, the fifth cluster faces an even bigger problem. The high number of COVID-19 cases is not followed by the reach of internet services. Based on the population of two regencies and two cities, only 70.58% on average has access to the internet. Implementation of mobile applications in the fifth cluster needs to be preceded by improvements in internet infrastructure. Then, in the sixth cluster, which consists of five regencies and four cities, there is a need to increase the reach of high-speed internet services to maximize the benefits of a mobile application that has been running to handle the pandemic.

Table 3. Typology of cities and regencies included in the 100 Smart City movement in Indonesia.

City/Regency	Cluster	Characteristics
10 regencies: Batang, Blora, Klaten, Langkat, Musi Banyuasin, Pematang Siantar, Sukoharjo, Tabalong, Wonosobo 9 cities: Banjarbaru, Binjai, Magelang, Padang Panjang, Palembang, Pontianak, Sibolga, Surakarta, Tanjung Pinang	First cluster	<ul style="list-style-type: none"> • A low number of confirmed COVID-19 cases • Have any mobile application to handle the pandemic • High internet penetration
10 regencies: Banyuwangi, Blitar, Bogor, Bojonegoro, Gresik, Kulonprogo, Lamongan, Pelalawan, Situbondo, Sumbawa 6 cities: Cimahi, Cirebon, Kediri, Madiun, Sukabumi, Yogyakarta	Second cluster	<ul style="list-style-type: none"> • A low number of confirmed COVID-19 cases • Have any mobile application to handle the pandemic • Low internet penetration

Table 3. *Cont.*

City/Regency	Cluster	Characteristics
9 regencies: Gunungkidul, Indramayu East Lombok, East Luwu, Morowali, Pasuruan, Siak, Sumenep, Tuban 3 cities: Batu, Jambi, Probolinggo	Third cluster	<ul style="list-style-type: none"> • A low number of confirmed COVID-19 cases • Do not have any mobile application to handle the pandemic • Low internet penetration
12 regencies: Banjar, Banyuasin, Boyolali, Deli Serdang, Demak, Grobogan, Jepara, Mimika, Muara Enim, Padangpariaman, Pati, Solok 10 cities: Ambon, Balikpapan, Banda Aceh, Bontang, Cilegon, Jayapura, Manado, Mataram, Pekalongan, Tomohon	Fourth Cluster	<ul style="list-style-type: none"> • A low number of confirmed COVID-19 cases • Do not have any mobile application to handle the pandemic • High internet penetration
2 regencies: Cirebon, Purwakarta 2 cities: Bekasi, Kupang	Fifth Cluster	<ul style="list-style-type: none"> • A high number of confirmed COVID-19 cases • Do not have any mobile application to handle the pandemic • Low internet penetration
5 regencies: Bandung, Bantul, Jember, Sidoarjo, Sleman 4 cities: Banjarmasin, Bogor, Depok, Semarang	Sixth Cluster	<ul style="list-style-type: none"> • A high number of confirmed COVID-19 cases • Have any mobile application to handle the pandemic • Low internet penetration
Regency of Badung 2 cities: Medan, Padang	Seventh Cluster	<ul style="list-style-type: none"> • A high number of confirmed COVID-19 cases • Do not have any mobile application to handle the pandemic • High internet penetration
6 regencies: Banyumas, Kendal, Kutai Kartanegara, Kutai Timur, Magelang, Tangerang 8 cities: Bandung, Denpasar, Makassar, Pekanbaru, Samarinda, Surabaya, Tangerang, South Tangerang	Eighth Cluster	<ul style="list-style-type: none"> • A high number of confirmed COVID-19 cases • Have any mobile application to handle the pandemic • High internet penetration

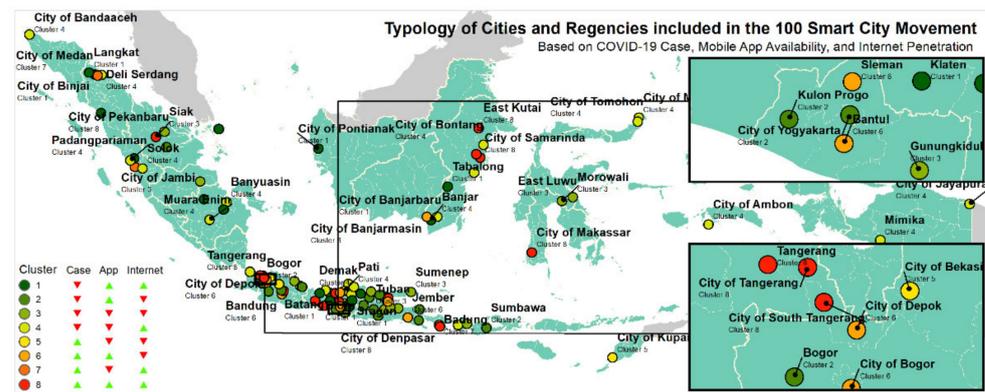


Figure 9. Distribution map of the typology of cities and regencies included in the 100 Smart City movement in Indonesia, based on confirmed COVID-19 cases, mobile app availability, and internet penetration.

7. Discussion

Today and in the future, smart cities with digital technology innovations have a significant role to play before, during, and after global pandemics, integrating Internet of Things (IoT), Augmented Reality, Virtual Reality, Big Data, Blockchain, and AI [73]. However, the aim of this paper has not been to discuss the abovementioned concepts in much detail, albeit they can certainly offer important discussion forums for other academic researchers in many different study fields.

Much of the current COVID-19 debate concentrates on the application of ideas and insights into smart technology in the field of urban planning and design [12]. This is related to challenges in the field of urban development in the future as a consequence of the recent pandemic. COVID-19 has pushed for spatial mobility change given its social restrictions [74]. Moreover, human mobility has been profoundly affected by the virus as simplified by technology, the implementation of smart cities with innovation strategies, standards and platforms, operating models, and execution plans [75]. Nevertheless, there are still many people who have not been able to adapt to the policy of social distancing, as exemplified by London, United Kingdom (UK) [76]. The acceleration of digital transformation in all fields of life and the use of various applications have caused cities in the future to think about their prospective designs and planning. This, in turn, requires contribution from various fields of societal expertise. Importantly, future transformation must be adapted to current city conditions [77]. At least with the experience that has been gained, we can be better prepared for pandemics of the future [78].

People’s activity patterns and daily lives have been greatly influenced by the pandemic. To tackle the spread of the virus, several cities and regencies that are included in the 100 smart cities in Indonesia implemented the concept of a smart city to prepare themselves for ICT-based applications. Our results show that several innovative applications have so far been hugely beneficial to society in several Indonesian cities and regencies. Based on the description of the benefits of the applications above, the scope of the applications can be identified in relation to prevention during the COVID-19 pandemic, namely in the fields of government services, health, economy, and education.

This paper thereby contributes to the existing research literature in terms of having provided a critical overview of various applications and their specific utilization in Indonesia during the pandemic. The applications under investigation here are all included in the Smart City Masterplan. In addition, there are also applications that can be traced through the website of the city and district governments, which are also included in the 100 Smart City movement, as part of the program of the Ministry of Communication and Information of the Republic of Indonesia. Perhaps most importantly, this paper argues that these pivotal applications have provided crucial help in providing public services that can be accessed more quickly, easily, and safely during the current pandemic.

Some applications are related to particular government services, such as in the case of “Inovasi SIAP Lapor,” which monitors real-time security in villages. It is important to monitor security since the number of crimes committed during COVID-19 has increased [79]. “Pikobar,” developed in Bandung, is used to find out who is eligible to receive social aid. “Surabaya Single Windows” (SSW) facilitates online licensing processes in Surabaya. “Dukcapil Dalam Genggaman,” developed in Surakarta, facilitates population administration services. As for the health sector, “Jaki,” developed in Jakarta, scrutinizes the movement of individuals through QR codes. “Ambulance Hebat,” developed in Semarang, is a health service center that guarantees the needs of communities in times of medical emergencies. In the economic sector, “Makindekat,” developed in Bali, facilitates shopping needs so that people do not have to leave their homes. “TemuWA,” also developed in Bali, offers online buying and selling services more generally.

As for education and training sectors, “Makassar” aims at supporting students in their studies and helping them understand lesson materials better; innovation PPBD SMP Online, facilitated by the Agency for Education, supports easy remote registration regarding secondary schools by using cellphones and laptops. “Baruga Sikola,” in turn, can be used to support students in their home study. “PPDB SD” and “PPDB SMP,” facilitated by the Surabaya City Education Office, helps with the registration of new students at elementary and junior high schools.

The above applications have been very supportive in the realization and implementation of smart cities, especially with regards to the impact of COVID-19. The virus has acted as an effective catalyst for change when it comes to the use of ICT, as well as to the efforts to increase the achievement of smart cities. The future needs of cities are expected to be further integrated with ICT to improve people’s quality of life, especially in reference to the elderly, who need to be able to access virtual connections [80]. In the future, it is necessary to think about how the existing applications can also be accessed by the elderly in society. The concept of an age-friendly city consists of three different aspects: communication and information, outdoor space and buildings, and social participation. ICT can help in this by integrating these aspects to improve the quality of life of seniors [81]. The different types of smart technologies that may be integrated with each other in the future must be placed in line with local, national, and international policies to achieve true inclusiveness and age diversity through inclusive, sustainable, and equitable cities and societies [82]. Romania is one of the countries predicted to be the oldest country in the European Union. The country has already signaled some promising plans to develop smart cities to improve the quality of life of its elderly, sustainability and opportunities, accessibility, and mobility and connectivity. However, the goal of creating smart and age-friendly cities in Romania has also been challenging due to neglecting age-friendly cities in the country’s long-term strategies and policies, which are simultaneously prioritizing infrastructure projects [33]. Meanwhile in Indonesia, the work from home policy is allegedly able to increase the use of ICT, digital literacy, and work productivity [83]. It can also be maintained that all age groups have experienced profound changes due to COVID-19.

8. Conclusions

The use of smart city applications can increase the effectiveness of providing government services to the public, which is then encouraged to perform these activities, raising their overall levels of productivity, safety, and well-being. While there are various applications found in different cities and regions, some of them have very similar characteristics and benefits. Therefore, when designing an application that supports the implementation of smart cities of the future, it is indeed necessary to make plans that are based on the actual needs of society and then adapt the application to these circumstances. In so doing, we can also take relevant examples from specific cities or regencies, which have proven successful in their approach in the past, and apply them to others.

We conclude that human capital is very key when developing smart city applications. It is thereby necessary to encourage people to use them. Indeed, this should be the ultimate

aim of every government, i.e., that the society is able to make use of the applications at optimum levels, in order to effectively face the changes and challenges of the future. Activities, such as socialization, could further boost the awareness of these applications. Their very existence needs to be intensified and accelerated so that people become more familiar with them and how to make effective use of them, particularly with regards to socialization through social media, which is so widely used in today's society.

In the future, cities and regencies need to structure themselves in a smarter way by making use of applications to reach societal efficiency in their implementation of different city arrangements. This is also to improve the digital literacy of society more generally. Only then can a smart city, particularly the dimensions of smart living and smart environment, be truly achieved, which is then supported by a smart society in the future. In addition to merely providing these applications to the public, cities and regencies need to conduct more cutting-edge research into sustainable spatial planning, public spaces, facilities, and transportation. The so-called support applications also need to be taken into careful consideration. It is possible that after the COVID-19 pandemic, more services accessible through applications will become available.

On the one hand, the strength of this paper lies in the fact it precisely shows that a variety of smart city applications employed by different cities and regencies to overcome the challenges of the COVID-19 pandemic exists. The limitation of this paper, on the other hand, is that it fails to critically compare and contrast existing smart city applications in Indonesia to other similar applications in other countries. This is partly because the characteristics and needs of each city and regency of each country and continent are so fundamentally different. In the future, greater cooperation between different countries should be encouraged in terms of the design of the applications so that their use could be assessed globally.

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