Article

Innovation in Coping with the COVID-19 Pandemic: The Best Practices from Five Smart Cities in Indonesia

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Abstract: In relation to innovations which help to cope with the COVID-19 pandemic, the best practices of several smart cities become an important input to organize and create strategies for future cities. This research aims to identify the responses of cities to the COVID-19 pandemic; analyze their innovation in tackling the COVID-19 pandemic; and create strategies and planning for the future of the cities. This study analyzes aspects such as the use of information and communication technology (ICT), smart city implementation, the biological disaster of the COVID-19 pandemic, the environment, and spatial plans. This research was carried out in five smart cities using a case study. The results indicated that each case had innovations for coping with the COVID-19 pandemic. They showed a uniqueness and local innovations adapted to the problems faced in the five case areas. The innovations were demonstrated by the use of ICT-based applications in several public services as part of smart city implementation. The concept of a smart city, which addresses the biological disaster of the COVID-19 pandemic through the existence of ship-based isolation centers and sociotechnical innovations, was then adapted in various cities throughout Indonesia. In terms of the smart environment concept, this is translated through technological and social innovation approaches to improve medical and domestic waste management, public service systems, and the socialization of environmental protection programs in cities during the pandemic. The COVID-19 pandemic is allegedly accelerating the implementation of the smart city concept in spatial planning. There is a tendency for the use of public space in the city center to shift to local-scale service centers. Additionally, other activities are increasingly occupying the digital space so that it affects the arrangement of spatial organization and increases the need for ICT infrastructure. The efficient and flexible use of applications for supporting the implementation of smart cities needs to be broadened for the public services provided by both the government and private sectors. Meanwhile, in relation to the dimensions of a smart environment, it is necessary to take into account the waste management as a result of COVID-19. The same case is the aspect of spatial planning in which it is necessary to redesign open spaces for public use. City planning in the future also needs to be capable of the smart mitigation of non-physical disasters, such as the COVID-19 pandemic.

Keywords: innovation; smart city; pandemic; COVID-19; cities

1. Introduction

Coronavirus disease 2019, commonly abbreviated to COVID-19, is categorized as a pandemic as it covers almost all the highly populated regions of the globe. Due to the COVID-19 pandemic, physical distancing and lockdowns have been applied in many cities in different countries. One of the implications of this is the implementation of working from home (WFH), caused by the need for social distancing. Working from home leads to

other changes in life, such as the methods of working, fulfilling daily needs, interacting with other people, and making use of spaces [1].

From the result of the previous study, the implementation of smart cities during the COVID-19 pandemic in Indonesia shows an increase, particularly in the dimension of smart governance [2]. This can be seen from ICT-based public services, a higher intensity of public information, and the use of different applications to support the availability of public services [2]. Meanwhile, the aspects of the smart economy and smart branding, the strengthening of Usaha Mikro, Kecil, dan Menengah (UMKM) (micro, small, and medium enterprises (MSMEs)); and innovations in products and marketing by utilizing ICT are greatly increasing. In addition, there are changes to people's lifestyles, especially in the access of economic services for daily needs, and an increasing number of goods are now ordered online. The strengthening of a smart society is related to local wisdom, such as maintaining the habit of collective working that is reflected in people's ability to face hardships because of the COVID-19 pandemic. Meanwhile, in relation to a smart environment and smart living, the culture of a healthy life and the environmental awareness of society can be seen from people's habits of using disinfectant at home and from their willingness to wear a mask in public. This can indirectly increase the sale of products made by MSMEs. On the other hand, the ICT-based service provided by the government is one of the major concepts in implementing smart city. During the COVID-19 pandemic, this is greatly helpful and makes it easy for society to access services since they do not need to queue for these services, and thus the possibility of crowds is reduced. In addition, this can prevent society from leaving their home for public services so that the advice of staying at home can be followed.

In relation to the use of ICT, we are currently in an era that has experienced much progress compared to the era before the use of ICT. Cities are strongly encouraged to become smart cities. Likewise, in rural areas, they have begun to recognize the use of ICT and have begun to develop it into a smart village [3]. Therefore, urban planning, as well as spatial planning, needs to consider the progress of the city by applying the smart city concept. When considering the implications of policies, the use of virtual space is greatly helpful in solving problems due to the limited city space for economic services (banks, retail, etc.), business and offices [4,5].

Urban spatial planning reflects major spatial issues and technological developments. One of the issues that affects the practice of urban planning is the response to the public health crisis. Throughout history, humans were affected by several disease outbreaks, from the Black Death, cholera, and Spanish flu to COVID-19. Although these diseases had negative impacts on mankind, they also played a role in changing urban environment planning and management [6]. Cholera outbreaks triggered the introduction of modern urban sanitation systems and the importance of mapping the spread of the disease [7]. When the bubonic epidemic occurred, slum areas were cleaned, and quarantine facilities were built [6]. Then, the Spanish flu pandemic at the beginning of the 20th century prompted the introduction of waste management and regulations on the intensity of spatial use in residential areas [8]. The shift in work culture and the reduced long-distance traffic during the COVID-19 pandemic is proving that congestion and compactness may no longer define a city's success. The progress of providing digital infrastructure allows low-density cities or even villages to achieve economic agglomeration. For this reason, various smart city indicators are needed to measure the extent to which ICT infrastructures played a role in urban planning and development [6].

During the COVID-19 pandemic, three fields have experienced a very rapid change in using ICT-based virtual space: education, economy, and health [2]. In addition, ICT-based virtual spaces in the governance field, particularly related to public services, are also increasing. The government has so far provided ICT-based public services through various applications [2]. People are able to access public services online so that mobility can be minimized because of the use of virtual space and has an impact on city management [9]. An example of this is related to economy. During the COVID-19 pandemic, the sale

of different products in an online way is seen to have been able to increase the use of virtual space even though MSMEs had made use of ICT in promoting their products and purchasing what they needed before the pandemic. Increasing the use of virtual space related to MSMEs supports the implementation of smart city and smart region [10].

The concept of smart city has been implemented in many cities of different countries so that they can be more functional and smarter than ever before [11]. The implementation of smart city has also greatly supported the achievement of better city management [9]. The same case is the environmental aspect [9,12]. The concept of smart city is indicated as the one that has experienced a lot of changes to a smarter way of management. Smart city constitutes a regional concept that is useful to help solve problems in most aspects of life and that is intended to reach better city and environment management by making use of smart technology [9,12,13]. Not only do cities get a chance to become a smart city, but also regencies. Considering that most areas in regency are still in the form of rural areas, the focus and approaches made to develop a smart city in regency should be different. Therefore, it is necessary to initiate and develop smart villages so that not only the city develops to become smart [14,15].

It is also necessary to convey the concept of a smart city related to disasters. This is considering that the paper also analyzes the COVID-19 pandemic as a non-physical disaster. Few efforts to link smart cities with disaster aspects have been made. This paper is among the earliest to discuss it. Smart cities are defined as a system to cope with and/or to minimize unforeseen disasters by optimization of resources, for example through a comprehensive smart city model that includes all activities for disaster risk reduction in its planning [16]. Disaster management in smart cities may be translated into different practices, starting from the data-driven approach up to the application of artificial intelligence for decision support systems on disaster management, i.e., how to protect critical facilities during crises to expand its resilience to the tiered effects of a disaster [17].

Smart city is a concept of using information technology focusing on the integration of information to provide solutions to city problems and to be able to create a better city [18]. Better environmental and urban management is the main goal [9,12,13]. In this context, the environment is both a component and the goal of the implementation of a smart city. Smart environment can be defined as the use of technology to improve the knowledge of environmental conditions and services to alter people's behaviors, benefit the environment and increase the efficient use of resources [19]. It plays a role in improving the quality of the environment and in overcoming environmental problems so that city residents could feel the improvement in the quality of life. It can be materialized through interconnected and coordinated environmental management with the help of technology and social innovation [18,20,21]. The technology should be able to oppose environmental hazards, which are due to the impacts of the latest challenge, including the COVID-19 pandemic [22]. Smart environment is deliberated as one of the most promising approaches to solve the existing problems caused by COVID-19 [23].

What then needs to be studied are (1) what cities have achieved in relation to the COVID-19 pandemic; (2) how the innovation of smart cities helps to solve COVID-19 pandemic; and (3) what the planning strategies are for future cities after the COVID-19 pandemic. This will be an input in the future in relation to how to implement smart cities during a pandemic time and face post-COVID-19 pandemic time. Based on the questions mentioned above, this study is intended to identify how cities have responded in relation to COVID-19 pandemic, analyze the innovation in tackling COVID-19 pandemic, and making strategies and planning for the future of cities.

2. Materials and Methods

During the COVID-19 pandemic, innovations are needed to handle it. This is the case in Indonesia, which has the fourth largest population in the world. The large number of people in Indonesia, and especially in big cities that are densely populated, requires good handling through innovations. A case study on five smart cities in Indonesia, namely the

city of Jakarta—which is referred to as the province of the Jakarta Special Capital Region (DKI Jakarta) in this study—Surabaya, Semarang, Makassar, and Banyuwangi Regency is a good step to make it a best practice. This is because the five smart cities are often examples of good smart city implementation in Indonesia. Among the five smart cities, one of which is a district area, namely Banyuwangi, part of which is a rural area. However, all of these case studies include the 100 Smart City Indonesia Movement which is handled by the Ministry of Communication and Informatics.

This research applies the method of case study which puts an emphasis on studying contemporary phenomena related to real life [24]. The research on case study also constitutes a method used to collect naturalistic facts (a real-life context) [25]. This research focuses on current issues and is directed at the use value for human life; this explains how a city or regency from the government and community side in dealing with the COVID-19 pandemic through innovations.

In practice, research on case study is possible to have no control where there are only a few cases studied but they can be studied deeply [25]. The explanation is focused more on what is apparent or what is unique from the case [26]. In this case, the study covers cases in five different cities and regency mentioned above because in implementing smart city they show something typical and unique. Therefore, the digging for primary data in this research is conducted through qualitative data in the form of in-depth interviews with different source informants (resource persons). In-depth interviews are conducted with an expert on smart city and organizations of regional forces related to the implementation of smart city by using application and ICT related to planning, such as the Agency for Communication and Information and the Board for Regional Development Planning. In addition, organizations of regional forces assigned to COVID-19 and its impact on society, such as the Board for Regional Disaster Tackling, are also included in in-depth interviews. Meanwhile, an in-depth interview with the Agency for Spatial Plan and the Agency for Living Environment is conducted to obtain information relating to the strategy for developing the city in the future. Meanwhile, the collection of secondary data through literature study is carried out to identify the policies of regional governments in the forms of regional regulation, decrees issued by the regional leader, circular, and letter of mandate.

3. Results and Discussion

The research results achieved so far are the aspects of ICT-based application and smart city during the COVID-19 pandemic. These include COVID-19 pandemic disasters, smart mitigation, environmental aspect and smart environment, and spatial planning.

3.1. Aspects of ICT-Based Application and Smart City

The implementation of smart city has played a significant role in the achievement of better city management [3–9]. Smart city has been a global phenomenon. Many cities in different countries have been applying the concept of smart city so that they can function in a much better and smarter way [11]. The concept of smart city indicates that a city has changed a lot in city management, from conventional methods to a much smarter way. Smart city becomes a regional concept that can help solve most aspects of life and is aimed at achieving better management for city and environment by using smart technology [3,9,13]. Smart city, along with its characteristics, has an influence on city performance in the future [27]. The implementation of smart city is able to push infrastructure development, both social and modern communication infrastructure. This will result in sustainable growth and a better quality of life [28,29]. The development of ICT and application is really able to support the realization of smart city. ICT and application are of a great help in solving regional problems. Both ICT and application enable society to convey their aspiration and to simplify access to public services [13–30]. Public services that society can access in an online way strongly shows that mobility can be minimized because of the use of virtual space [31]. With the policy of working from home, supported by making use of

ICT, the mobility of people from home to workplace can be reduced. This leads to positive impacts on traffic, air pollution, and the need for office space [1].

Several cities declaring themselves as a smart city have made a breakthrough by making use of ICT-based applications during COVID-19 pandemic [2]. The implementation of smart city in Indonesia is based on the 2017 Guidelines of Making Smart City Masterplan-Movement toward 100 Smart Cities issued by the Ministry of Communication and Informatics of the Republic of Indonesia. The component of smart city consists of six dimensions, i.e., smart governance, smart branding, smart economy, smart living, smart society, and smart environment [9]. In facing the COVID-19 pandemic in Indonesia, based on the previous result of study, the implementation of smart city shows the increased use from the side of smart governance through ICT-based services and strengthening public information. Meanwhile, from the sides of smart economy and smart branding, the strengthening of UMKM, product innovation, and promotion, by making use of ICT, is quite prominent. This indirectly leads society to change their style in accessing economic services to online in order to fulfill their daily needs. Smart society is also strengthened by exposing local wisdom in facing this hard condition because of the COVID-19 pandemic. For smart environment and smart living, healthy living and environmental awareness are strongly emphasized to become a habit in society. On the other hand, ICT-based service that the government provides is the realization and implementation of smart city. During the COVID-19 pandemic, ICT-based service is very beneficial and makes it easy for society to receive different services. In relation to the use of ICT, we are now living in the future of cities that have made lots of advances. In the future, cities and regencies will have to reorganize themselves in a smarter way by making use of application [2]. On the implementation of smart-society dimension, there is a means for accommodating complaint from society in the form of call centers. It is the Agency for Communication and Informatics that runs the application for the purpose mentioned above in order that the service is more efficient and effective to run. Cities are strongly encouraged to become a smart city.

The condition of ICT to support smart city and overcome COVID-19 in Jakarta City, the city of Makassar, and the regency of Banyuwangi can be identified based on the WiFi available in public spaces, signal coverage, and internet users as well. In general, based on the side of infrastructure, Jakarta City, the city of Makassar, the city of Semarang, and the regency of Banyuwangi are similar in terms of the infrastructure condition, just like big cities in other countries. Equitable infrastructure is the key to smart city during the COVID-19 pandemic. One concrete example of DKI Jakarta's efforts to realize infrastructure acceleration during the COVID-19 pandemic is through the launch of the JakWifi program to reach people who are unable to access digital services. In fact, the program also targets slum villages in supporting the success of distance learning during the COVID-19 pandemic. This digital transformation momentum is also used by the DKI Jakarta Provincial Government to develop data integration for the people of DKI Jakarta Province. This can be proven from in-depth interviews as follows:

"In 2020, Jakarta initiated the JakWifi program. To support distance learning is basically an equitable infrastructure. So, it is not only accessible to people who are able to access digital services but also to those who cannot. Because of that, we installed and provided free WiFi services in 445 slum Rukun Wilayah/Hamlet (RWs), and, currently, there are 3500 points in 445 slum RWs. This is one of the government's efforts to build equitable infrastructure". (Informant: Head of the DKI Jakarta Communication, Information and Statistics Agency).

"Then, the DKI Jakarta Provincial Government, in terms of digital transformation, will later be one of the goals if from us, from the side of the Jakarta Smart City manager, we have activities related to digital transformation which will later change all DKI Jakarta residents' data and integrate DKI Jakarta residents' data in any way, for example, such as population data, social assistance data, education data, tax data, funeral data, health data, and so on, are integrated into one and will later form a kind of thing called digital

ID. All DKI residents will get one digital ID account through the "Jakarta Kini" (JAKI) application where people only need to enter their digital ID to access all information related to themselves". (Informant: Head of the Jakarta Smart City Information Technology Infrastructure Implementation Unit).

However, there are constraints in providing public services during COVID-19 pandemic, such as uneven availability of infrastructure, a limited budget due to refocusing it on overcoming COVID-19, a limited number of human resources in charge of ICT, and lack on ICT knowledge in society. In particular, the city of Makassar has so far developed telecommunication infrastructure in the framework of the "Makassar Sombere" Program and smart city by building up to 21 towers. The development of telecommunication infrastructure in the respective city is aimed at providing society internet connection for free, especially when they pay a visit to public library available in sub-districts, villages, and small islands outside the city. At present, there are 67 points spreading in villages where internet connection is available. In addition, there are also 153 containers found in villages. This can be proven from the in-depth interview with an informant, quoted as saying:

"...those 67 points had already been in operation before COVID-19. Meanwhile, those additional 153 will be allocated as containers in village poskos functioning as a health service center related to COVID-19 and other health needs." (Informant: Tasks Executor, Head of the Agency for Communication, and Informatics (Kominfo), city of Makassar).

The implementation of smart city in the regency of Banyuwangi refers to the Regent's Regulation Number 60 Year 2017 on the implementation of a smart-city masterplan through Banyuwangi Smart Kampung [32]. Smart Kampung is a concept for developing society in a community. This is so they can do things in a smart and efficient way to overcome problems arising in accordance with their resources available in a region. In the region, society form communities with life orders related to local custom and norms. Smart Kampung becomes a solution for online services related to documents, permits, and demographical affairs. Besides, Smart Kampung can also be used for serving admission to the COVID-19 vaccination and integrated social aid. In the regency of Banyuwangi, the implementation of smart governance is really of primary prominence during the COVID-19 pandemic. The aspect of it is called the public service mall. At present, the public service mall serves 199 kinds of service to society under one integrated roof. Besides, the regional government of the respective regency also provides another service which is electronically based that supports the aspect of smart governance. It is in the form of applications comprising smart kampung, "Program Peti Kemas", "Camping Embun" (Camping Pelayanan Masyarakat Kebun/Service Camping of Garden Community), and "Bunga Desa" (Bupati Ngantor di Desa/Regent at the Office in Villages). The development of smart economy during the COVID-19 pandemic in the respective regency is implemented by pushing UMKMs to use marketplace for promoting their products. One form of innovation in smart economy is "E-Bilaperlu". The handling of COVID-19 through the dimension of smart government is by establishing a Simpling Program and "Bagiak" (Bank Sampah Giat Keliling/Mobile Garbage Bank). Meanwhile, in relation to smart living and to minimize the risk of getting virus infected, 3T (testing, tracing, and treatment) is also strongly implemented. Efforts to adapt from smart branding during the COVID-19 pandemic are achieved by optimizing the Banyuwangi Tourism App. In accelerating information to reach villages, especially during the COVID-19 pandemic, the Banyuwangi Regency Government has installed fiber optics down to the village level. This was also conveyed by one of the informants as follows.

"We share all the data down to the village level because we already have fiber optic, and we distribute it to the dashboard of each village. So, the data on deaths, people who are positive for COVID-19, people who are hospitalized, data on recovered people and isolation, have been shared with villages so that villages can map their own risks." (Informant: Head of Regional Development Planning Board of Banyuwangi Regency).

"Our strategy is to maximally utilize IT to help provide services to the community, including developing the existing web." (Informant: Head of Living Environment Agency of Banyuwangi Regency).

The implementation and activity of smart city in the city of Makassar can be found from its Smart City Masterplan, or frequently called Makassar "Sombere" and smart city. Smart city, in the context of handling COVID-19, is more focused on an effort to accelerate COVID-19 handling by integrating, connecting, and coordinating different Organisasi Perangkat Daerah (OPDs), i.e., a regional force organization, in the respective city. They are formed to a unit as a solution alternative that is able to overcome arising problems in the respective city. By revising the quick win of a smart city masterplan as well as modifying and making new quick wins in the context of handling the COVID-19 pandemic, the following six activities can be realized: Makassar Recover or Smart Emergency Protocol Against COVID-19 and Service (Recovery), online integrated permit service, the "Karester" Program, online tax payment (e-tax), the "Dongkelor" program, and saving of garbage bank. These are examples of innovation or a prominent program in handling COVID-19 in the city of Makassar. Such innovation constitutes an effort or measure in accordance with the protocols of handling and providing services related to the COVID-19 pandemic in a fast and measurable way. Makassar Recover is a form of the seriousness of the City Government of Makassar in handling the COVID-19 pandemic and it is stated in the Makassar Mayor's Regulation Number 5 Year 2021 [33]. Makassar Recover Ecosystem as a program in handling the COVID-19 pandemic in the respective city is implemented in three main stages: health immunity (comprising 11 phases), social adaptation (comprising 9 phases), and economic recovery (comprising 6 phases). These three stages are implemented simultaneously in the respective city so that the people can feel the benefit of the program [34].

The involvement of society in the city of Makassar can be seen from the installment of CCTV there. So far, there have been 5000 CCTVs installed in public places there, 4000 of which were installed by the local government and 1000 by local people. Those 5000 CCTVs are connected to one another, and they were installed in accordance with the standard set by the local government. The involvement of local society in the implementation of smart city in the city of Makassar becomes a strategy for the local government in the implementation of smart city in the future. of the achievements of Makassar in handling COVID-19 is also reflected in the programs of Sikamasita ("sistem kepedulian elektronik warga miskin dalam program penanggulangan kemiskinan"/electronic care system for the poor in the program of poverty handling), Sibagas ("sistem informasi balla garring sombere dan smart" bertujuan untuk memberikan informasi ketersediaan fasilitas RS/information system of balla garring sombere and smart measure, aimed at giving information about available facilities in hospitals), Sisrute (sistem rujukan pasien terintegrasi/integrated referral system for patients, used in hospitals), and karester (program penanganan kebencanaan COVID-19 berbasis masyarakat/society-based handling program for COVID-19 disaster). On the dimension of smart living, the city government of Makassar creates an innovation called Sugisura (Suplemen Gizi Untuk Rakyat/Nutrient Supplement for People). Besides, the dimension of smart economy is also encouraged by digitalizing UMKM products in cooperation with Grab as an effort towards economic recovery. This cooperation is called the UMKM Hunt Program. Since 2019, when this program was established, the income that UMKM make has increased up to 194%. In terms of the application service to support UMKM, the city government of Makassar also makes cooperation with *ayo m* and was facilitated by *osio* team. In addition, the city government of Makassar also facilitates the actors of UMKM in receiving BPUM (Bantuan Produktif untuk Usaha Mikro/Productive Aid for Micro Entreprise) through Diskop (Dinas Koperasi/Agency for Cooperatives) of South Sulawesi and the Ministry of Cooperatives and UKM.

Then, the implementation of smart city in the city of Semarang, especially related to the dimension of smart society, focuses on the aspect of health. It provides the data related to ward availability in hospitals, data of hospitals, data of public health centers, health dashboard, smart governance with JIS (Jendela Informasi Semarang/Semarang Information Window), and STRONG (Integrasi Data Warehouse Penanganan COVID-19 /Integrating Warehouse Data on COVID-19 Handling). Smart economy is realized in

the form of an application service called 'Gulo Asem (Gerai Usaha Mikro Lokal Online Asli Semarang/Stand for Genuine Online Local Micro Enterprises of Semarang). Besides, there is also another application called "TUMBASIN". It is an online buy–sell platform or e-commerce for goods in traditional markets. The use of this application is also an effort to minimize the spread of COVID-19 because shoppers do not have to go to a traditional market for shopping. Traditional markets are especially susceptible to the spread of COVID-19. The same case is in Surabaya. Information about COVID-19 in the city of Surabaya can be obtained from various applications/services. They are, for example, https://lawanCOVID-19.surabaya.go.id, accessed on 24 October 2021 (information on COVID-19) e-health service (online admission in a hospital for a new patient) and application of "E-PEKEN" Surabaya (facilitating vendors in management and purchasing transaction). The existence of the E-PEKEN application aims to maintain the economic stability of MSMEs during the COVID-19 pandemic. The government also requires ASN (State Civil Apparatus) to shop at least once a month using this application. Meanwhile, for product delivery to buyers, sellers can choose to deliver themselves or use a delivery service. This can be proven from an in-depth interview with an informant, as quoted: "the existence of the E-PEKEN application aims to maintain the economic stability of MSMEs during the COVID-19 pandemic". The government also requires ASN (state civil apparatus) to shop at least once a month with this application. Meanwhile, for product delivery to buyers, sellers can choose to deliver themselves or use a delivery service. This can be proven from an in-depth interview with an informant, as quoted:

"For payment for products purchased by ASN, State Civil Apparatus can use QRIS, which is a joint payment system with Bank Indonesia using a QR code. Profits and economic movements are quite large, if one ASN spends around Rp. 100,000–500,000, then approximately the circulation of money can reach 1 billion per month." (Informant: Head of Evaluation, Research and Development Division of Regional Development Planning Board of Surabaya City (BAPEKKO Surabaya)).

In addition, Surabaya also utilizes the PPDB website for school admission for new students; Siagus; ePendidikan (media for integrated services by the Agency for Education); Surabaya e-ID (process for data submission) application; online administrative services (https://wargaklampid-dispendukcapil.surabaya.go.id/, accessed on 24 October 2021); Surabaya Single Window (SSW); complaint service (https://mediacenter.surabaya.go.id, accessed on 24 October 2021); and application "WargaKu", which functions as a media for complaints and services for residents of the city of Surabaya. Through this application, Surabaya residents can submit criticisms, suggestions, requests for information, and complaints against the city government of Surabaya. In line with Makassar City, in terms of supporting infrastructure, the Agency for Living Environment, led by the Semarang city government's plans to install analytical CCTV, is used to monitor the volume of waste so that it can be handled quickly.

In general, the implementation of smart city during the COVID-19 pandemic is intended to strengthen, prevent, and minimize the spread of COVID-19. The implementation of smart city in Indonesia is adapted to the concept, vision, and mission of the regional government, as well as the city's needs, the priority for city problems, and the involvement of stake holders in city development. The difference in problems because of the COVID-19 pandemic in every region makes it possible to strengthen the dimensions of smart city for every region in a different way, particularly in those five regions where this study was conducted. The dimension of smart governance becomes the strongest one compared to the other dimensions in handling COVID-19 in the province of Jakarta and the regency of Banyuwangi. This is because the urgency of the transformation service, from previously manual to digital, makes it easy for society during the pandemic. Unlike the province of Jakarta and the regency of Banyuwangi, the city of Makassar and Semarang emphasizes the dimension of smart living because society in those cities do experience the benefits from it in handling COVID-19. Meanwhile, the dimension of smart society becomes the

most influential in tackling COVID-19 in the city of Surabaya. Table 1 contains applications and services during COVID-19 in each region.

Table 1. Matrix of application and service comparison during the COVID-19 pandemic.

Location of Study	Smart Governance	Smart Branding	Smart Economy	Smart Living	Smart Society	Smart Environment
Province of Jakarta (DKI Jakarta)	• Alpukat Betawi (administrative service) • One-door integrated permit service		• Jakarta Alert for COVID-19 • JakOne Mobile • Jakpreneur	• Safe Jakarta • Qlue (complaint service) • Jaki (Jakarta at present)	• i-Jakarta (digital library) • Tije (Transjakarta) • KRL-Access • MRT-J	• Jaki (Jakarta at present)
Regency of Banyuwangi	• Banyuwangi Smart Kampung • Laman COVID-19 Banyuwangi • Service for Adminduk Dukcapil (ID Documents) • Bunga Desa (Regent at village offices) • Camping Embun (camping services for garden communities) public service mall	• Banyuwangi Tourism App	• Innovation on UMKM's side • E-Bilaperdu • Wenak (Warung Naik Kelas/class promotion stall) • A friend of public entreprise • Top farmer • Shopping day at UMKM and public market • Online single submission (OSS)	• Provision of isolation rooms • Stipulation for referred jospitals • Data taking for citizen's mobility as an effort of case tracking in COVID-19	• Program of smart student • Social safety network, nutrience for pregnant and feeding mothers • Data taking and distribution of social aid	• Simpling (online environmental quality assessment) • SIMPEL (online regular environmental report) • Frequent mobile garbage bank /Bagiak (garbage saving)
City of Makassar	• Makassar data open platform • Layanan NTPD 112 • Kucata'Ki	• Mobile story telling • Big Data for tourism human resource (BIASAMATA • Application for job information • Smart library card • e-Pustaka of Makassar	• (SIPAKATAU) Sistem Pelayanan Pajak Online Terpadu/online integrated tax service system • e-Tax	• Care and rescue center • Home care • DOTTOROTTA • Makassar smart card • Siaga emergency for disaster • SUGISURA • Makassar recover • Website info for Corona Makassar • E-puskesmas	• Information system for data management of citizens with social welfare problems • Movement of 'Touch The Heart' based on forum/discussion • Save the City	• Healthy Lane • Center for street vendors • Garbage bank • Sangkasarung
City of Semarang	• Applications for permits and documents through an online system • Robot public services • website siagacorona.semarangkota.go.id, accessed on 24 October 2021 • Musrenbang online • Situation room • SI IMUT (intergrated service system for space and building matters) • One Map	• Branding UMKM by making a mask	• Gulo Asem (Application for small- scale industry and UMKM) • Ijus Melon (Online Entreprise Permit) • Authority credit	• Ambulance Hebat • Halo Doc • Universal health coverage	• WiFi provision for society	• Monitoring water and air condition • Zeta Green (air purifier)
City of Surabaya	• Surabaya single window (SSW) • Surabaya against COVID-19 • KLAMPID (Online service for birth certificate, mortality, divorce, etc.), • E-letter • Surabaya's media center • *Hotline* 112 • E-planning Surabaya		• Application E-PEKEN Surabaya	• E-health Surabaya • SITS CCTV Surabaya	• Website for school admission for new students • Website for online school report card • Website SIAGUS (alertness for teachers) • E-education • Application of Wargaku (my citizen)	

3.2. Aspect of COVID-19 Pandemic Disaster and Smart Mitigation

The COVID-19 pandemic, as a biological threat, gives us a lesson that there are various threats of disaster. It means that the understanding about risk is quite complicated and dynamically affects the way we live, earn a living, and maintain health [35]. Therefore, any efforts to minimize disaster risk have to be defined as a sustainable measure that needs to be taken in every disaster management cycle (before, during, and after) [36]. This is in line with the framework of Sendai stated in the 2015–2030 Minimizing Disaster Risk which begins with (i) understanding of disaster risk; (ii) strengthening of risk management of disaster; (iii) investing in minimizing disaster risk for strength; and (iv) improving readiness to face any disaster as an effective response in the framework of rebuilding for better condition related to recovery, rehabilitation, and reconstruction [37].

Efforts to overcome the COVID-19 pandemic as a disaster are different in one country from the others, despite its general preventive measures and technical guidance recommended by World Health Organization, such as health protocols (wearing a mask, washing hands with soap in flowing water, keeping distance with other people, avoiding the crowd, and reducing mobility) and vaccination. An effort to mitigate risk disaster constitutes making interdisciplinary decisions involving political, social, economic, and epidemiological aspects as well as other fields for assessing risk to make alternatives for minimizing risk in an appropriate way [38]. Responses to overcome the COVID-19 pandemic can be identified in the early and alert stages (indicated with an increasing number of global cases) in accordance with the emergency stage in the context of disaster risk management. Meanwhile, the transition stage (indicated with the decreasing number of global cases) is correlated with the recovery stage (rehabilitation and reconstruction) [39]. Regional policies were set out at a different level from national to provincial, until the regency's degrees were also applied in the five smart cities as cases where this research was conducted, namely the cities of Jakarta, Makassar, Semarang, Surabaya, and the regency of Banyuwangi., i.e., the minister's decision, the governor's decision, regional regulations, regional decisions, and regional circular. This paper attempts to highlight the smart mitigation applied in the five cases study by using the primary criteria which are the use of technology as well as innovations in dealing with COVID-19 problems.

Makassar City brought an interesting topic to be discussed in the smart mitigation measures by its "Sombere" smart city policy including Makassar Recovery Systems (MRS) [40] with different task forces and sociotechnical innovations. MRS becomes a prominent innovation in overcoming COVID-19. It focuses not only on the health aspect, but also social adaptation, and economic recovery. This innovation is especially needed for the marginal groups who suffered a lot from the pandemic, as stated by [41]. For example, the loss of social and economic capital for a group of marginalized people can lead to worse conditions and the ability to face crisis and recovery from disaster is hard. In the social economic aspect, the use of technology was also inserted in a community empowerment program for informal workers, such as financial aids intended to those working in online transport services (including Gojek, Grab, and Mr. Lunch). In the health aspect, many innovative actions were conducted with different task forces, namely COVID Hunter, Satgas Raika, Master COVID, Satgas Detector, and COVID-19 Command Post (Posko). COVID Hunter aims to conduct the 3T measures, while Satgas Raika's function aims to break down the crowd. The COVID Hunter structure is inserted in the public health center available at the sub-district level. In Makassar, there are at least 47 public health centers armed with COVID Hunter. There are 1000 officers from different governmental institutions (a special police unit for reinforcing government regulations, the Department of Transportation, the Regional Disaster Management Agency, and Police at the Provincial and City level) as well as volunteers identified as Satgas Raika. Master COVID is a task force coordinated by the Department of Health of Makassar City at the sub-district level whichs aims to deal with COVID-19 patients. There are fifteen sub-districts in Makassar and each of them is reinforced with Master COVID to deal with the cases in each sub-district. Satgas Detector has its function to take early actions in overcoming COVID-19 cases. It involves

community participation from the lowest and the next-to-lowest administrative unit called Rukun Tetangga (RT)/Neighborhood/sub-hamlet and Rukun Warga (RW)/hamlet. Some activities are conducted by the Satgas Detector, such as promoting public awareness and education surrounding COVID-19 and its preventive measures, while some personnel in this task force are trained by the Indonesian Doctor Association to conduct early screening, i.e., taking temperatures, checking oxygen saturation and blood pressure, etc. A barcode is therefore dedicated for everyone as an identity that a particular person was monitored by Satgas Detector. Satgas Detector also aims to monitor socioeconomic situations of the community/individual to facilitate the data mining for social aids as well as to monitor other contagious diseases such as tuberculosis. While 1000 COVID-19 Posko were distributed across the city at the level of RW. Such efforts to involve society in preventing COVID-19 from spreading is also applied in different countries, such as China and South Korea [42]. These socio technical innovations with different task forces in Makassar City are then adapted in different cities across Indonesia, i.e., Jakarta City, Bandung, Sidoarjo, Kediri, Tulungagung, Bangkalan, Lamongan, Madiun, Jember, and Probolinggo.

"COVID Hunter was really initiated in the city of Makassar and so were Detector and RAIKA Teams. It was COVID Hunter that Jakarta replicated." (Informant: Tasks Executor, Head of the Agency for Information and Communication, Makassar City).

In addition to the sociotechnical innovations established in Makassar City, a program entitled Integrated Floating Isolation has operated in the city of Makassar since 2 August 2021. It is a program which aims to accommodate COVID-19 patients who need to be self-isolated. It uses the ship of Kapal Pelni Umsini floating as far as 1 km away from the coast. Despite the non-technological-based aspect, this bright innovation is in character with Makassar City due to its geographical position (coastal city) and the limited number of hospital beds while ensuring minimal virus spread since it is isolated with very strict protocols for those coming in and out from the ship. Integrated Floating Isolation is one of the solutions to overcome the problem of the limited number of wards belonging to hospitals in the city of Makassar. The operational cost for Integrated Floating Isolation is taken from the budget of unexpected aid belonging to Badan Penanggulangan Bencana Daerah (BPBD), Regional Board for Disaster Management. Besides BPBD, other OPDs that are involved in taking roles are the Agency for Transportation (in charge of transportation), the Agency for Communication, and Informatics (in charge of setting applications on ships and networks), and Satpol PP (in charge of handling general works). It is a program which substitutes the program of floating tourism that was previously run by the provincial task force, and it was then transferred to the city government. This is in line with the statement of an informant in an in-depth interview, quoted as follows.

"Last year, there was a COVID tour run by a provincial task force. It took place in hotels. However, now there is no more COVID tour because it is now run by the city government. Therefore, especially in Makassar, we run a floating isolation now." (Informant: Tasks Executor, Secretary of BPBD, city of Makassar).

The same idea was then implemented in another island in Indonesia, Belitung. The idea of using a ship has in fact been applied in the USA and Japan where several liners are used for the same purpose [43,44]. Different measures taken by Makassar City to strengthen the health system are in line with the Sendai Framework for disaster risk reduction. To minimize the risk of disaster, it is necessary to strengthen the firm health system as well as integrate the management of risk disaster into health service on every level [45]. Besides the Makassar Recovery Program (a program specially designed to overcome COVID-19 in an integrated way), the city of Makassar also has another program called the Karaster Program (a program that is set to tackle any disasters, including COVID-19 disaster, but is based on society).

The 3T (tracing, tracking, and testing) measures are seen as an integrated one that plays an important role in controlling the number of COVID-19 cases [46–48]. In line with the instruction stated on the Regent's circular of the regency of Banyuwangi Number 440/481/429.112/2020 on Alertness and Prevention for COVID-19 [49], the 3T measures

are implemented with the role of all OPDs in the regency of Banyuwangi. Even though OPDs are not related to health, they play an important role in helping minimize the risk of getting infected with COVID-19 by accelerating the measures of testing and tracking. Besides, they also do the COVID-19 data entry onto the dashboard in order that society can receive information immediately. This can be explained by an informant quoted as saying below.

"All activities have to support one another. The same case is for overcoming COVID-19. For example, for the last two weeks, almost 40% of the Bappeda's employees have been involved in tracing and data entry from the field, and the data do not only belong to Bappeda. This is an example of a contribution from Bappeda." (Informant: Head of Regional Development Planning Board of Banyuwangi Regency).

The implementation of 3T by local health professionals with the help of OPDs in the regency of Banyuwangi is integrated to one another in every three sub-districts where there are also three agencies in charge of responsibility. For example, the sub-districts of Pesanggrahan, Siliragung, and Bangorejo are monitored by the Agency for Living Environment, the Agency for Tourism, and Agency for Public Works. An informant is quoted as saying below.

"So, we, all agency heads, are divided to oversee monitoring vaccination and tracing. Three agency heads are used for three sub-districts. Thus, we must work together to make the implementation of vaccination and tracing successful. Even though we are not from a medical field, our presence is psychologically of a great help." (Informant: Head of the Agency for Living Environment, the Regency of Banyuwangi).

In Semarang, closed-circuit television (CCTV) was also employed to monitor public mobility during the restricted mobility period after the issue of the Regulation of Semarang Mayor Number 6 of 2021 on "Third Change of the Regulation of Semarang Mayor Number 57 Year 2020 on the Implementation of Limiting People's Activities" [50]. During that period, public mobility for education, performing arts and entertainment, and tourism activities were tightened, and some economic activities were only permitted from 6 am to 11 pm. People's mobility is monitored by making use of ICT through CCTV equipped with face recognition and it is installed in several road intersections. However, when there is a motorist or driver caught not wearing a mask, sanction in the form of monetary fines will only be given if the violation has been committed several times. It is important to highlight public awareness in the first step rather than giving any financial punishment. In addition, the local government uses images from the CCTV to analyze public compliance with the health protocols, i.e., the use of masks in public areas. In other countries, based on the results of research [51], it was proven that the restriction of activities is able to lower the spread of the COVID-19 pandemic. Despite the pros and cons to this mobility restriction measure, a study from [45] highlights the necessities to establish global protocols that all countries need to agree and sign to face this global pandemic [45].

In the city of Surabaya, the policy related to overcoming COVID-19 cases can be obtained from its several law products. They are in the form of the mayor's decisions and regulations. There are 25 law products related to the policy for overcoming COVID-19 cases in the respective city. One of them is about the implementation of health protocols for the prevention and severance of COVID-19 spread in the respective city. It is stated in the Mayor's Regulation Number 10 Year 2021, which represents the second change over the one number 67 Year 2020 [52]. Unfortunately, it can be said that tackling of the COVID-19 pandemic in the city of Surabaya is still of dissatisfaction. Some efforts to overcome COVID-19 that have been performed in the respective cities involve conducting massive 3T (test, trace, and treatment) at the entrances of Surabaya City and Madura Island as one of the efforts of the government of the East Java Province, Surabaya City, and Madura Regency to reduce the spread of COVID-19. The city of Surabaya is also considering risk zoning. The risk zoning has been plotted up to the RT and RW levels where there are around 153 kelurahan/village administrative units (1300 RW and 9100 RT), following the rules from the central government for zoning mapping regulations. If a case occurs in the

area, it will be handled regionally. The Surabaya government also provides health facilities, limits people's activities in public, and conducts vaccinations. Health facilities provided in the city of Surabaya are hospitals to which COVID-19 patients are referred, public health centers, portable washstands, sterilization booths, and hand sanitizer available in many places. Yet, what the city of Surabaya has accomplished is still not optimal yet, since the rate of COVID-19 cases is still high there.

In those five cases, there are various efforts to overcome the disaster of the COVID-19 pandemic. Nevertheless, the city of Makassar is an example of regions that has made different innovations to minimize the disaster risk by involving society and making use of technology in a good way to respond to the disaster of COVID-19 pandemic. The city of Makassar is also an example of cities where the COVID-19 pandemic is well managed. It was even, compared to other cities, the last city that the COVID-19 pandemic affected. A good response to overcome the COVID-19 pandemic led by the regional government and society of the city of Makassar resulted in lower rates of COVID-19 spread in the respective city than that in other cities. Compared with the number of cases in Jakarta (859.345 cases), Surabaya (66.685 cases), and Semarang (88.083), the number of COVID-19 cases in the city of Makassar remains low (48.453), as stated by one of informants as well as proven by secondary data (Table 2).

Table 2. Total cases of COVID-19 in five case studies.

Number of Confirmed Cases of COVID-19 until 12 October 2021 (in Person)					
City/Regency	Hospitalized	Recover	Death Toll	Self Isolation	Positive Case
Province of Jakarta (DKI Jakarta)	310	844.538	13.550	947	859.345
City of Surabaya	41	64.102	2.545	7	66.685
City of Semarang	13	67.973	4.457	-	88.083
City of Makassar	176	47.271	1.006	-	48.453
Regency of Banyuwangi	29	11.897	1.688	-	13.614

Source: [53–57].

"The city of Makassar reflects a good government response to COVID-19 pandemic. As stated in the statistical data, the number of COVID-19 cases in this city is relatively low". (Informant: smart city supervisor for the city of Makassar).

Table 3 shows that the five study areas take advantage of the internet to communicate the risk towards its population by using official specific websites dedicated to COVID-19 disaster management and/or by using government official social media (Facebook, Twitter, Instagram, etc.). Spatial analysis using COVID-19 case data was also employed in five areas to inform the publics about the condition of pandemic condition in the region and in micro level, i.e., spatial distribution of COVID-19 cases (hot spots) in maps or even interactive maps (i.e., in Jakarta), micro zonation of COVID-19 cases (active cases, deaths toll, etc.), as well as the number of vaccinated persons and its distributions. The results of spatial analysis were also used as a basis for the 3T (tracing, tracking, and testing) measures. Another measure taken in the study area involves software applications which are mostly used under mobile phone platforms. In Jakarta, an application entitled "JAKI" (Jakarta Kini), a one-stop service application, which is also used for COVID-19 prevention and disaster management. The users may take advantage of this application for different functions, such as consulting the information of COVID-19, COVID-19 vaccination registration (in collaboration with the Indonesian Ministry of Health through the "PeduliLindungi" application), and the PCare system (social security application) belonging to the Indonesian Social Security Administration (BPJS). In Makassar and Banyuwangi, a regional COVID-19 dashboard is used as a basis to conduct 3T measures. In addition, an application built by

the Indonesian Ministry of Health called "Silacak" was also added in this dashboard in Semarang. The "Silacak" application was targeted to health officials, the police, and the army for contact tracer purposes. As a national platform application, it can be run offline when data records in the areas have difficult network access. Another national application used to carry out the check-in/check-out process in crowded locations, registration for vaccinations, or tracing the contact history of people with COVID-19 is "PeduliLindungi". This application is created by the Ministry of Communication and Information, the Ministry of Health, the Ministry of State-Owned Enterprises, and the Indonesian National Disaster Management Agency. The latest is now used widely across the country. In addition to other measures, call centers were also utilized as measures in four study areas (Jakarta, Surabaya, Semarang, and Makassar) to provide 24/7 COVID-19-related services to the public. While in Jakarta, Surabaya, and Semarang, the call center number was the same, 112, or hunting added 1500–112. In Makassar, an additional number was also used and connected to Whatsapp to facilitate public information, while in Semarang, the call center was also equipped with doctor consultation via Whatsapp. In Surabaya, the call center 112 had an optimum time of response no longer than 7 minutes (instead of 15 minutes at the national level).

Table 3. Smart mitigation: the use of data and technology to cope with the COVID-19 pandemic.

Location of Study	Smart Mitigation					
	Website as a Tool for Risk Communication	Spatial Analysis	Software Application	CCTV	Call Center	COVID-19 Disaster Management Policy
Province of Jakarta	https: //corona.jakarta.go.id/, accessed on 24 October 2021	Mapping for spatial distribution of COVID-19 cases (hot spots). Micro zonation of COVID-19 cases	JAKI (Jakarta Kini) a digital platform (mobile apps) for information and public service		Call center 112	
Regency of Banyuwangi	https://corona. banyuwangikab.go.id/, accessed on 24 October 2021		Regional COVID-19 dashboard			
City of Makassar	https://infocorona. makassar.go.id/, accessed on 24 October 2021	Mapping for spatial distribution of COVID-19 cases (hot spots). Micro zonation of COVID-19 cases			Call center 112; 081–1400112 (Whatsapp)	Sombere Smart City with Makassar Recovery System and its task forces and socio technical innovations.
City of Semarang	https://siagacorona. semarangkota.go.id/, accessed on 24 October 2021	Mapping for spatial distribution of COVID-19 cases (hot spots) Micro zonation of COVID-19 cases	Regional COVID-19 dashboard Silacak application	CCTV in road intersections equipped with face recognition	Call center 112; 1500–112; online doctor consultation (Whatsapp)	
City of Surabaya	https://lawanCOVID-19.surabaya.go.id/, accessed on 24 October 2021	Mapping for spatial distribution of COVID-19 cases (hot spots) Micro zonation of COVID-19 cases			Call center 112 with a optimum time of response no longer than 7 minutes (instead of 15 minutes at the national level)	

The COVID-19 pandemic suggests this disaster is dynamic (the number of cases is changeable, and the case spread is very fluctuated) which can lead to multidimensional crises. Smart mitigation is seen as an effort to integrate the use of technology and information to cope with disaster problems in a specific region within a certain period of time. In addition, a multi-hazard disaster risk perspective is needed to better prepare a region with different hazards (natural, biological, etc.). Furthermore, it is necessary to apply a disaster risk perspective using a helix cycle of disaster phases rather than a single circle of disaster phases with its variety of intensity as well as frequency [58]. In that perspective, disaster risk reduction efforts will be conducted continuously (in pre-, during, post-disaster management phases) and adapted to different possible hazard(s) in that area. In the pre-disaster phase, steps such as monitoring and collecting information of the possible threat must be

given to society without fail. It can be facilitated using information and communication technology (website, social media, etc.). During the disaster (emergency) phase, early warning systems and risk communication are therefore vital, i.e., Big Data can also be used for aid distribution monitoring and disaster risk communication [59]. The use of ICT for overcoming a biological disaster (epidemic/pandemic) may be translated into different actions, such as for diagnosis, protection, and emergency through artificial intelligence, telemedicine, GIS, etc. [60].

3.3. Environmental Aspect and Smart Environment

The COVID-19 pandemic represents a new challenge for smart city, especially the smart environment dimension. Regarding COVID-19, the environment has a two-sided coin: it can contribute to the spread of COVID-19, but it can also receive the impact of COVID-19 [61]. Smart environment should be able to answer this challenge by tackling all the new environmental problems emerging caused by the COVID-19 pandemic without ignoring the existing environmental problems in cities by involving all parties from the individuals and the community to government levels by using the appropriate technological supports [18,22,23]. This is necessary not only to attain productivity, sustainability, and livability of cities, but also to deal with COVID-19 problems [20].

In the context of smart environment, identification of environmental problems can be a starting point to determine appropriate environmental management efforts. From the literature review, it is known that there are direct and indirect impacts of the COVID-19 pandemic in the context of the human–environment system [62–64]. The direct impact is related to public health risks, economic recession, food crises, and psychological problems [61,65,66]. Meanwhile, the environment receives indirect impacts, both positive and negative [67,68]. The COVID-19 pandemic has led to improvements in the environmental quality of various cities in the world, as indicated by the decrease in air and water pollution, the decrease in global greenhouse gas (GHG) emissions, the decrease in noise levels, and the decreasing pressure on tourist destinations, which allows improvements in the ecological system, including the protection of biodiversity [69,70]. However, the reduction in global carbon emissions has its own compensation at the domestic level where domestic waste, both inorganic and organic, as well as the consumption of water and electricity at the household level actually increased [71]. An increase in domestic waste and medical waste occurs as an implication of working from home, an increase in online shopping activities from home and during self-isolation activities for COVID-19 patients, as reported in Canada, the United States, and China [72,73]. If not properly managed, this waste can become a medium of transmitting the COVID-19 virus and can increase the burden of urban waste management [62]. This can be seen from cases in the province of DKI Jakarta, the city of Makassar, the city of Semarang, the city of Surabaya, and the regency of Banyuwangi. Different priorities have been made through government regulations or policies to overcome the environmental problems during the COVID-19 pandemic.

During the COVID-19 pandemic, there were major environmental problems of concern in all locations of study, i.e., the province of DKI Jakarta, the regency of Banyuwangi, the city of Makassar, the city of Semarang, and the city of Surabaya. In accordance with what happened in other cities in the world, an increase in both organic and inorganic domestic waste as well as medical waste has become an environmental problem which requires special measures [62,72,73]. This is due to an increase in public consumption as a consequence of the recommendation to stay at home and work from home. The increase in COVID-19 cases in each city has also led to an increase in medical waste, such as masks and personal protective equipment (PPE), mainly from health facilities and households due to self-isolation. This, of course, affects the city's waste management system. This is proven by the results of an in-depth interview, as follows:

"…. from April 2020 up to now, the amount of waste we handle is around 60 tons/day on average, and now it's 180 tons/day. This is from domestic/household waste. The medical waste changes, too. For industrial waste, Banyuwangi has a fishery processing

industrial center, in Muncar Sub-district, to be specific. With this change in life in the people who usually eat out, it turns out that the demand for fast food or canned/castorite food is increasing. In this case, this is for exports and domestic needs." (Informant: Head of the Agency for Living Environment, regency of Banyuwangi).

"It is clear that this is an environmental problem. For example, masks just worn by society is a problem. If it's in the hospital, it's clear where the waste is. The mask worn by society becomes a polemic because a lot of them are thrown into our landfill." (Informant: Head of the Agency for Living Environment, city of Makassari).

''In total, the amount of waste we managed decreased during the pandemic, but the local waste production increased. We managed infectious waste from houses because infectious waste from health centers and hospitals has been managed by the Agency for Health." (Informant: Head of the Agency for Living Environment, city of Semarang).

In the context of handling COVID-19, all environmental programs made in provinces or cities must be in line with regulations issued by the government and must support the efforts to break the spread of COVID-19. Besides that, to address waste problems during COVID-19 pandemic, there are several national regulations issued that should be followed by city government as well: Law No. 18 of 2008, concerning waste management [74]; and circular letter of the Minister of Environment and Forestry (MenLHK) Number SE3/MENLHK/PSLB3/PLB.3/3/2021, regarding the management of B3 waste and waste from handling COVID-19 [75].

The province of Jakarta (DKI Jakarta) has many programs integrated with the smart city platform, JAKI. Problems related to household infectious waste are solved by introducing a waste pick-up service. People only need to contact call centers distributed all over the province. Concerning the national regulation, the government made a development plan of the Intermediate Waste Management Facilities, encouraging the public to participate in the waste bank and to start initiating waste at the household level through trials in several districts. This information is delivered continuously through social media, websites, and JAKI. Not to forget the existing programs, the government also concerns air quality monitoring and flood information systems that are integrated in JAKI as well as COVID-19 information.

To handle environmental problems, especially waste during the COVID-19 pandemic, the regency government of Banyuwangi made several programs for society and business actors to participate in the efforts to improve environmental quality. In relation to waste management, the regency of Banyuwangi runs the Giat Mobile Garbage Bank (Bagiak). It is a pick-up service of the domestic waste that is created to minimize the mobility of people. People can collect and exchange their waste into money or staple food without leaving their house. This innovative program can encourage community participation in managing waste easily [76]. Not only focusing on waste management, the regency of Banyuwangi also has other application programs implemented during the COVID-19 pandemic, namely Simpling (environmental quality measurements) and SIMPEL (regular environmental reporting). Simpling facilitates companies who need to have a particular environmental assessment by registering their request through the website and sending samples through a delivery service. Before the COVID-19 pandemic, the registration process was conducted manually. The simple program is a change in the company's routine compliance reporting service from the manual method by collecting physical documents to reporting through the system. All the documents just need to be uploaded onto the system. This change in service mechanism is also experienced by the city of Semarang where field visits are not directly conducted in the process of applying for environmental permits by entrepreneurs, but through online checking mechanisms, through videos or photos. Apart from these three programs, the government is still concerned to run the existing programs related to general environmental protection, particularly the environmental supporting capacity (DDL), and rearrange the environmental quality index (IKLH) in several sub-districts and water spring protection programs ("Mentari"). These programs aimed to also strengthen the new programs initiated during the pandemic. However, several parts of the program

must be performed on the spot and cannot be replaced by online activities, such as tree planting in the "Mentari" program. The adaptations made were limited to the application of health protocols and limiting the number of participants attending. This is also stated in the following in-depth interview:

"To provide services under this COVID condition, we use two featured innovative digital programs, namely Simpling (SIMPEL) and Bagiak. However, for other programs not covered by the featured digital programs, to provide services, we handle directly . . . " (Informant: Head of the Agency for Living Environment, Regency of Banyuwangi).

Unlike the regency of Banyuwangi, the city of Makassar has Tabungan Sampah "Anak Lorong Program" ("Sangkasarung"), as well as Tabungan Sampah Anak Lorong program (Sangkasarung), a waste bank program initiated by the community and supported by an application. This application facilitates the communication between "Anak Lorong", a waste bank community, and the waste bank managed by the government (Agency for Living Environment). However, its effectiveness still needs to be improved because it largely depends on the features of the application and the community members' ability to use the application [21].

"The city of Makassar waste bank program is called "Sangkasarung". Sangka means savings, so "Sangkasarung" stands for Anak Lorong waste saving. So, why is it called Anak Lorong waste bank? As a matter of fact, there is already a waste bank, but Anak Lorong waste bank is a kind of small-scale business entity. When the pandemic hit, the waste increases, so the program expanded to be community-based." (Informant: Smart City Supervisor of the city of Makassar).

In addition to the waste bank program, the city government of Makassar is also trying to establish cooperation with private sectors, namely Garbage Mall and Octopus (a private company). This collaboration helps the city government to manage waste in the city of Makassar. Garbage Mall and Octopus have existed since before COVID-19 pandemic, but the collaboration with the Agency for Living Environment has become more intense after COVID-19 pandemic. Furthermore, the Agency for Living Environment has also initiated the existence of a waste power plant (PLES) and the provision of a final disposal site (TPA) in the form of a sanitary landfill site. These two initiatives are planned to be realized in late 2021 or early 2022. Another initiative related to waste management is the use of maggot for household organic waste processing. In the context of the smart environment, what the city government of Makassar does not only provides solutions to the waste problems but also provides solutions related to renewable energy sources [22]. Apart from waste, the use of the public cemetery (TPU) in the city of Makassar as a burial place for COVID-19 patients is also initiated to help the people of the city of Makassar access funerals more easily. Previously, the dead bodies of COVID-19 patients were buried in a central cemetery designated by the provincial government. Enhancing the availability and optimization of green open space is assumed as the way to support the programs created during the COVID-19 pandemic.

In line with the city of Makassar and the regency of Banyuwangi, the city of Semarang also focused on waste management during the COVID-19 pandemic. Infectious waste from the households is managed through the drop box and safety box programs. Drop boxes, placed in every kelurahan and village, are temporary containers, especially for infectious waste, such as masks and tissues. Drop boxes are mainly placed in integrated isolation areas managed by the kelurahan or village, while the Agency for Living Environment will transport the waste and bring it to the infectious waste collection site in the city of Semarang. Spraying non-chemical disinfectants, using eco enzymes, is also run to reduce the potential for COVID-19. In coordination with firefighters, this program is focused on public place disinfection, including streets and garbage dumps. The Zeta Green (Air Purifier) program is also conducted in several spots of public buildings in the city of Semarang, initiated by private sectors and academics. Socialization regarding waste sorting and management is a challenge. Therefore, to be able to disseminate this information more extensively, the Agency for Living Environment works closely with the target groups and the waste bank

groups. The use of social media is also considered an effective medium of communication and education, especially during the pandemic. Social media is able to create environmental awareness, where its use is widely used to support environmental campaigns so that a lot of people can be connected through environmental issues [77]. In connection with the realization of smart city in the city of Semarang, the city government of Semarang also used the Internet of Things (IoT) in the form of CCTV for environmental management. At the moment, CCTV is used to monitor security and traffic by placing CCTV at Simpang Empat (crossroads and road intersections), and waste production is monitored by placing CCTV in the market. The Agency for Living Environment itself mainly uses waste monitoring information at the final garbage site. During the pandemic, the technical installation of CCTV was quite hampered so that the realization of this program was also delayed. The use of IoT is very important to obtain real time data so that certain patterns can be identified and can be used for quick and appropriate decision making [78].

Same as other cities, the city of Surabaya also put attention to waste separation. The government, particularly the Agency for Living Environment and of Cleanliness and Green Open Space, are cooperating to separate the waste in temporary garbage dumps before transporting it to landfill. The government is currently synergizing with a university, namely Institut Teknologi 10 November (ITS) Surabaya, by conducting research about recycling mask waste in order to avoid its potential in spreading COVID-19 [79]. River improvement is the existing program that is still prioritized during the pandemic.

Overall, during COVID-19 pandemic, the smart environment was implemented as part of a smart city which aims to suppress the spread of COVID-19. The smart environment is implemented as part of a joint effort to solve the environmental problems emerging due to the COVID-19 pandemic or exacerbated by the pandemic. Smart environment does not stand alone, but its existence is connected, and it strengthens other dimensions of smart city, such as disaster and spatial planning. The waste problem is a common thread of environmental problems in Jakarta City, the city of Makassar, the city of Semarang, the regency of Banyuwangi, and the city of Surabaya. Differences in initial environmental conditions, the understanding of the government, community capabilities, and the available options of existing technology determine priority differences in the programs being implemented [80]. Partnership, cooperation, and collaboration between the government and society, including private sectors, are not only needed at the technical level but also at the conceptual level in program planning, including the implementation of smart environment [21–81]. The pandemic demands changes in behavior, including the choice of programs run by the government, both internally and externally. This is coherent with [82] who stated that there was an effective change related to sustainability and social responsibility in the community during the pandemic (Table 4).

3.4. Spatial Planning Aspects

The COVID-19 pandemic has accelerated changes in the spatial order or spatial order in urban areas, from physically oriented to digitally oriented [83]. This limitation of mobilization and digital orientation has changed the people's lifestyle in an area. Population density and regional development were initially centered in the urban core zone. With this digitalization, redistribution occurs and provides opportunities for the surrounding buffer areas to develop to meet the increased local activities [84]. All efforts continue to be developed by local governments, through both regulations and innovation programs.

Table 4. Environmental program comparison during the COVID-19 pandemic.

No.	Location of Study	Environmental Programs
1.	Province of Jakarta (DKI Jakarta)	Household infectious waste pick-up service (via call centers) Optimization of social media (i.e., instagram), website (www.ksbbpersampahan.com, accessed on 24 October 2021), and Smart City platform ("JAKI") to inform the public about waste management and other programs initiated by the government Development plan of the Intermediate Waste Management Facilities Initiation of waste separation trial in several districts
2.	Regency of Banyuwangi	Pick up service of the domestic waste and convert it to a money saving. Besides money saving, people can change their waste with the stapple food (through the Giat Mobile Garbage Bank ("Bagiak") application) Online service for accepting and processing the request of environmental quality measurements from public ("Simpling") Online service for accepting the regular environmental reports from companies ("SIMPEL")
3.	City of Makassar	Expansion of waste bank that is initiated by the community to handle the increasing amount of waste during pandemic (located in every alley) Education of waste separation through waste bank (organized by the government) and Sangkasarung (community-based waste management) Collaboration between government and private sector in waste management (Garbage Mall and Octopus) Initiation of waste power plants and sanitary landfill Provision of a public cemetery for COVID-19 patients
4.	City of Semarang	Provision of particular waste container for medical waste (drop box and safety box) in every kelurahan and village (in collaboration with corporates) CCTV for environmental monitoring (particularly waste) Optimization of social media in educating people about environmental protection during the pandemic Disinfection of public space by eco-enzyme spraying Zeta Green (air purifier)
5.	City of Surabaya	Infectious waste separation in a temporary garbage dump Cooperation with academics (Institut Teknologi 10 November (ITS) Surabaya) in conducting research on recycling mask waste so as not to infect others or spread the virus

Aspects of spatial planning in the context of handling COVID-19 in Jakarta City, Makassar City, Surabaya City, and Banyuwangi Regency are conducted based on regional policies and regulations. During the COVID-19 pandemic, there has been an adjustment to urban spatial planning, which touches on aspects of transportation, housing environment, improvements in the health facility system, and the transfer of physical use of public spaces to digital spaces [85]. The transfer of the function of physical public spaces to digital spaces is related to the limitation of physical interaction in every work activity, such as setting quotas and controlling people coming in and coming out in an area that may create crowds.

Public facility spaces are still used with adjustments in accordance with the health protocols applied, for example in Jakarta cities. This is conducted by implementing minimum distances between visitors, transferring certain functions to the online system, and adjusting operational times. The spatial planning aspect of Jakarta in the context of handling COVID-19 is also shown by the existence of regulations for protecting public health on public transportation. This is an important regulation for areas with a high level of mobility, such as Jakarta.

Meanwhile, the contributions and efforts made by local governments, especially Makassar City and Banyuwangi Regency in preventing and reducing the impact of the pandemic, were performed by revising the detailed spatial planning (RDTR) document by taking non-natural disasters (COVID-19 disasters) into consideration as risk factors that need to be mitigated. Makassar City specifically conducted a COVID-19 risk zonation study with the Kelurahan analysis unit, using web application-based analysis. The results of this study were then followed by spatial planning activities for small alleys in the C alley program, arranging the culinary area ("KANRERONG"), and arranging the burial space for COVID-19 dead bodies. Control of spatial use based on community reports is also facilitated online through channel 112 and the complaint post box. In addition, during the COVID-19 pandemic, the spatial planning of the city of Semarang was manifested in the arrangement of Kota Lama tourist area with the aim of expanding the new economy (culinary and souvenirs) to support the new normal, as well as spatial planning for the provision of new hospitals and health facilities in sub-districts which are far from the city

center, for example in Mijen District where a type D hospital is planned to be built in an effort to deal with COVID-19.

The COVID-19 pandemic has successfully changed the spatial order or spatial order in urban areas, from previously physically oriented to digitally oriented. There has been a change in people's lifestyles. They were not internet-based, and now they are internet-based, and this has made their life change. Working from anywhere is a very significant change that happens in almost all cities in Indonesia, including Jakarta as the capital city. This limitation of mobilization and digital orientation has changed people's lifestyle in an area. The population density and regional development were initially centered in urban areas; however, with this digitalization, redistribution occurs and provides opportunities for other areas around the urban areas to develop. All efforts continue to be developed by local governments, through both regulations and innovation programs. Regional development is no longer in the urban areas, but there is control and there needs to be a rethinking of the urban concept.

In the context of handling COVID-19 in Jakarta, aspects of spatial planning are conducted based on DKI Jakarta Governor Regulation No. 3 of 2021 for implementing Regional Regulations No. 2 of 2020 concerning the handling of coronavirus disease 2019 [86]. The spatial arrangement performed is related to the limitation of physical interaction in each work activity, such as setting quotas and controlling people coming in and coming out in a place that can trigger crowds, implementing a queuing system at the entrance with a distance of at least one meter, implementing an online reservation system for certain businesses, and implementing service hours in accordance with the policies set by the DKI Jakarta Provincial Government.

In the context of handling COVID-19, the spatial planning aspect of Jakarta is also shown by the existence of regulations for protecting public health on public transportation. This is an important regulation for areas with high level of mobility, such as Jakarta. The form of spatial planning in the aspect of public transportation includes restrictions on the transportation capacity of the facilities and restrictions on operational time. This restriction is adjusted according to the type of transportation. The capacity limitation for cars, buses, waterways, or trains is at most 50% of the capacity, while, for passengers on freight cars, there are two people per row at the most. This is different from online motorcycle taxis, which are allowed to carry passengers with a ban on crowding more than five people and are required to apply geofencing information technology to avoid crowds. In addition, in the context of handling COVID-19 in Jakarta, traffic demand management is also implemented, including increasing the efficiency and effectiveness of the use of traffic space and controlling traffic movements.

Aspects of spatial planning in the context of handling COVID-19 in Banyuwangi Regency are based on the policies and regulations of the Banyuwangi regency government. This can be seen in Circular No. 440/552/429.112/2020 on the closing and temporary arrangement of entertainment and business Activities which may create crowds to prevent the spread of COVID-19 in the Banyuwangi Regency area [49]. However, in its implementation, Banyuwangi Regency has not clearly considered the aspects of spatial planning in handling COVID-19.

Spatial planning during the COVID-19 pandemic has not changed much because COVID-19 is a non-natural disaster which is different from physically changing natural disasters. However, the consideration of the future of the pandemic will be used to prepare spatial plans because the materials have been prepared by the Banyuwangi Regency Government. The use of public spaces that has been closed due to COVID-19 risk zoning is also in the process of reopening, so that the community can use them. Those public spaces will be recorded and registered to the geoportal so that the public has the information which spaces they can visit, as explained by the following informant.

"We closed some public spaces, and we are in the process of proposing that the Ministry of Health open several public spaces, including tourist attractions. Later, we will input the data on our dashboard so that people will automatically know whether a place

or space in Banyuwangi can be visited or not." (Informant: Head of Regional Development Planning Board of Banyuwangi Regency).

Community is always involved in spatial planning aspects. Given the fact that the cultures and ethnicities in the Banyuwangi Regency vary, to minimize unwanted things from happening, the community and the religious leaders always participate in the process of preparing spatial planning and in solving certain problems.

In the context of handling COVID-19 in Makassar City, aspects of spatial planning are based on multi-level policies and regulations from the national, provincial, and city governments. Aspects of spatial planning as an effort to overcome COVID-19 in Makassar City are based on Circular No. 443.01/2021 and Mayor's Decree No. 1160 of 2021, restricting crowding social cultural activities, restricting eating/drinking activities on the spot, and restricting operating hours/times [87]. This is confirmed by the results of in-depth interviews as follows.

"Interaction between communities is limited by the imposition of restrictions on interaction in terms of religion, in terms of education, and other fields...because we are now in the red zone at level 4, community interaction with another community is restricted." (Informant: Tasks Executor, Secretary of BPBD Makassar City).

Contributions and efforts made by local governments to prevent and reduce the impact of the pandemic are conducted by revising the detailed spatial planning document (RDTR), taking into account non-natural disasters (the COVID-19 pandemic) and various other influencing factors that have been included in the consideration in the revision of content RDTR documents, especially in the development planning of health facilities and infrastructures. As a lesson from the pandemic, the accessibility and adequacy of health facilities is one of the main factors that can be planned in a spatial plan to become a resilient area from non-natural disasters [88]. The coordination and integration established between OPDs in the Makassar City government in the process of planning, revising, and implementing spatial planning documents during the COVID-19 pandemic is conducted offline (via relevant OPD representatives and the special committee) and online (DPRD/Dewan Perwakilan Rakyat Daerah/ Assembly at Regional, experts, and the community) to revise the Makassar City RDTR document. During the process, the community and spatial observers can contribute or participate online. Furthermore, policies and strategies for handling COVID-19 to support the new normal of Makassar City in the document revision will refer to the Regional Medium-Term Development Plan (RPJMD) and strategic environmental studies.

"At the moment, we are revising the RDTR. The revision is, of course, considering COVID-19 and various factors that we will revise. Since 2009 we have had it. We will make revisions which will be very much different from the ones in Makassar City." (Informant: Head of Socio-Cultural Affairs and General Administration of Regional Development Planning Board of Makassar City (Makassar City Bappeda)).

In connection with mitigation, Makassar City is handling COVID by considering zonation risks. To determine zonation risks in Makassar City, real-time web application-based analysis is used. The zonation risk classification is also adjusted in accordance with the classification of the central government. This makes it easier to interpret the implications of actions that need to be taken. According to the results of an in-depth interview with the Head of the Socio-Cultural and General Administration of the Regional Development Planning Board of Makassar City (Makassar City Bappeda)) the variables used to determine the zonation risks of Makassar City consist of three variables, namely the distance variable between the house and the "kelurahan", the variable of population density (population scale), and the variable of the number of positive cases in the area. These variables are slightly different from those used as input to determine the COVID-19 risk zone by the central government, which consist of the total number of confirmations, total suspects, total probable, and case fatality rate [89]. The detector task force, which detects risks (together with the health office), updates the number of cases in each sub-district and village, and then maps them. Based on the data, areas included in the high-risk

zone will be identified. For now, of 15 sub-districts in Makassar City, only 1 sub-district is in the green zone. This is because the sub-district is located in an archipelago, so it is estimated that the chlorine content in sea water can help prevent COVID-19, so that the sub-district is in the green zone. As for the areas that are included in the high-risk zone, special handling is conducted by BPBD together with forkopimda to be further handled by Babinsa, Babinkamtibas, together with RT and RW. This is in accordance with what the informant said based on the results of in-depth interviews as follows.

"After the implementation of this Pembatasan Sosial Berskala Besar (PSBB)/Large-Scale Social Restrictions there are certain spaces that are prohibited to use and the issue of time to use them. Of course, this involves several technical teams from the spatial planning office in collaboration with millennial communities who are concerned about GIS using our geoportal." (Informant: Head of the Socio-Cultural and General Administration of the Regional Development Planning Board of Makassar City (Makassar City Bappeda)).

Overall, Makassar City spatial planning during the COVID-19 pandemic was manifested in the spatial arrangement of alleys in Makassar City in the Lorong C program, which arranges the culinary area (KANRERONG) and the burial space for COVID-19 dead bodies. The spatial arrangement, especially in the alleys in Makassar City, can be seen from the Lorong C program. Lorong C is a program proposed to make the alleys in Makassar City beautiful by closing the gutters so that they do not smell and then pots placed on top of them. Makassar City Government also organizes a culinary area located in Karebosi Field which consists of various kinds of MSMEs called KANRERONG. KANRERONG is present as a culinary area that continues to run health procedures so that it can continue to operate during this pandemic.

In addition to focusing on structuring spaces on paths and culinary zones, the city government of Makassar also undergoes the space structuring for the funeral of COVID-19 corpses. Due to the phenomenon of pros and cons in society related to the location for the funeral of COVID-19 corpses, it is necessary to do the structuring of special area for the funeral of COVID-19 dead bodies in the respective city. The city of Makassar itself becomes one of the cities to which the COVID-19 patients are referred. Previously, the funeral for COVID-19 corpses were held in the special cemetery for COVID-19 dead bodies determined by the provincial government in Macanda, regency of Gowa. Macanda, located 15 km from the city of Makassar, was specially intended for the funeral of COVID-19 dead bodies. At the moment, however, the city government of Makassar has allowed society to hold the funeral for COVID-19 dead bodies in "Tempat Pemakaman Umum" (TPU), a public cemetery found in the city of Makassar. This is in line with the result of in-depth interview with an informant, quoted as saying;

"Specifically, from Makassar, those who died because of COVID-19 were buried in the cemetery determined by the provincial government. Now there has been a special policy from the city of Makassar that we are allowed to do the funeral for COVID-19 dead body in TPU owned by the city of Makassar." (Informant: Tasks Executor, Head of the Agency for Living Environment, city of Makassar).

Furthermore, the aspect of spatial planning becomes one of the programs stated in Makassar Recover. One of the programs found in Makassar Recover is related to the parking program. In limiting the movement or mobility of people in the city of Makassar as one of the efforts to overcome COVID-19 pandemic, the city government imposes a parking rate that is 10 times higher than usual. This is one of the efforts in order that they take public transport or online ojek (motor taxi).

Public services, especially related to space structuring (spatial planning products in the form of regional regulation, document of plans, and regional maps) in the city of Makassar, is centralized and can be accessed through PTSP of the city of Makassar. The online application service for permit of structuring on buildings is specifically called "ILEBAM". "ILEBAM" is an application-based service integrated with Web GIS-based online in which there are zones of space uses that can be the basis for the request of building permit.

Problems related to space structuring in the city of Makassar can be conveyed through canal 112, complaint box, or directly conveyed to the related technical agency heads. One of the obstacles and challenges found in spatial structuring during COVID-19 pandemic in the city of Makassar is the limited coverage and strength of internet connection to access services or coordinate spatial structuring in an online way. Besides, the lack of socialization and supervision in space structuring is also another obstacle. This can be proven from the result of in-depth interview with an informant, as follows:

"...everybody wants to make use spaces, but sometimes he does not know things related to limiting the use of space. Therefore, it is necessary to do socialization and encourage people not knowing to know so that they are able to help do socialization to others related to supervising the available spaces. So, the obstacle is that it is necessary to do the socialization and supervision from every layer of society to use space in a wise and correct way." (Informant: Head of the Socio-Cultural and General Administration of the Regional Development Planning Board of Makassar City (Makassar City Bappeda)).

The structuring for the tourism zone of Old City in the city of Semarang is the space structuring that is renewed. This is aimed at enlarging a new center for economic activities. From that structuring, it is expected that there will be new economic zones, particularly for culinary and craft trip. The space structuring of Old City is so important that new adaptation needs to be supported. This is proven by the fact that the latest structuring makes public spaces wider and more open so that physical distancing can be applied there. Therefore, sufficient public spaces, including green-open space, are so important in cities that they can support physical distancing [90]. However, the increasing spread of the second wave of COVID-19 represents a constraint. Furthermore, the structuring became slow because the new virus strain has an ability to spread more quickly. Consequently, outdoor activities were limited. Besides, the city of Semarang also has a tour bus program. With the restructuring of the Old City area, the tour bus is intended to make a stop there.

"With the restructuring and reopening of Old City, the tour bus is directed to making a stop there. Thus, those wanting to take this tour will be able to enjoy better service and arrangement to get to Old City. When they have been satisfied enjoying Old City, a tour bus will pick them up and take them to the starting place. Thus, integrating among programs has been realized. However, I have not made any discussion anymore on the improvement and adjustment because of the COVID-19 pandemic." (Informant: Smart City Counselor, city of Semarang).

Up until now, how the Old City was improved has not been found out because this is adapted to COVID-19. The area of Old City has been restructured in a significant way, but tourism is the most affected area during COVID-19 pandemic.

The space structuring of the city of Semarang is related to service zones of hospitals. Service zones are aimed at evaluating the availability of health facilities and making recommendation for the plan of building new health facilities in places where health facilities are still rare there. Based on the results of service zones of hospitals, suburb areas, such as the sub-district of Mijen, recommend building a new type-D hospital to optimize the handling of COVID-19. The distribution of health service is really important as part of handling COVID-19 pandemic. Besides, it is also useful to maximize the distribution of balanced health service without ignoring the role of hospital in fulfilling the need for health service beyond COVID-19 [91].

Meanwhile, space structuring in the city of Surabaya is a part of the strategies toward smart city, as stated in the document of Master Plan of Smart City Surabaya. Spatial planning is a part of the smart branding and smart living strategies. On the target of smart branding, integrated spatial planning is in need to materialize better city face. Meanwhile, on the target of smart living, harmonizing the spatial planning of a region is emphasized. The strategies optimize space-use control, fulfil the need for public space, provide proper home to live in, increase means of city utilities, and realize city friendliness to children, women, elderly, and disabled people.

In the context of making those aims come true, in the process of space structuring during COVID-19 pandemic, the city of Surabaya optimizes online systems, beginning with a planning stage, implementation, and control. Through the Regional Regulation Number 8 Year 2018, the city government of Surabaya has got the document of detail-scale spatial plan, which is operational as a reference in the implementation and control of space development. The plan of space use based on zones is presented in the form of WebGIS, and can be accessed publicly through the site of SIGIS (https://sigis.surabaya.go.id/, accessed on 24 October 2021), which is a collaboration between agencies within the Surabaya city government as the data guardian. This system is integrated with permit system through the Surabaya single window (SSW). Thus, the society there are able to make early analysis, make a permit request, and carry out the monitoring over the permit process of space use in an online way. The service of the Surabaya single window (SSW) itself is not only limited to location permits for space use, but also for other permits required for the opening of new activities. This service enables the users to do their affairs for different permits without direct contact with officers. However, monitoring space utilization is carried out with the system of the Surabaya 112 command center (hotline) and "Wargaku" (mobile apps), which allows the community to report irregularities in land use.

From the side of the government as the maker of development plan, there is also an application called E-Planning Surabaya. This application is based on the site web, which is used by the city government of Surabaya and related OPDs to formulate spatial plans and other development plans, such as the regional middle-term development plan and the regional short-term development plan. This all aims to realize harmonious and accountable development plan. Nevertheless, the process of space structuring during COVID-19 pandemic in the city of Surabaya still cannot be evaluated for more details because of lacking the monitoring over the implementation of the masterplan of smart city previously made.

With various systems in implementing smart governance, the city of Surabaya still faces operational obstacles from the citizens who are not familiar with the online system. This also gives rise to the emergence of illegal brokers who assist the use of the online system and who charge additional service fees beyond those regulated by the government.

4. Conclusions

The result of this study shows that the innovations for coping with the COVID-19 pandemic in each case study is characterized with programs and activities that are unique and typical in accordance with city and regional problems, and whether they are related to the aspects of ICT-based application or smart-city supporting applications, COVID-19 pandemic disaster, environment, and spatial planning. Innovation can be shown by the use of ICT-based applications in several public services as part of smart city implementation. Meanwhile, application has been highly implemented in relation to handling the disaster of COVID-19 pandemic. In this case, what is meant by disaster is the non-natural threat (i.e., the threat of biological disaster).

The concept of smart cities in dealing with the biological disaster of COVID-19 pandemic is applied in five cases to a different extent. The use of technology is shown for the example in Semarang using CCTV to control people mobility and dashboard use in Banyuwangi to conduct 3T measures. Despite the technological perspectives, the innovations for smart cities are clearly demonstrated in Makassar where innovations, such as ship-based isolation center and the sociotechnical innovations (MRS, COVID Hunter, Satgas Raika, Master COVID, Satgas Detector and Posko, Karaster Program). The latest is therefore adapted in different cities across Indonesia.

The waste problem is a common thread of environmental problems in five case studies during the COVID-19 pandemic. Differences in initial environmental conditions, the understanding of the government, community capabilities, support from academics and private sectors, and the available options of existing technology determine the program priorities implemented. The smart environment concept is translated through the technological and

social innovation approaches to improve the medical and domestic waste management, the public service system, and socialization of environmental protection programs in cities during the pandemic.

However, programs and activities related to the aspect of spatial plan in those five case studies are still limited, meaning that they do not do much about it. The COVID-19 pandemic has accelerated the implementation of the smart city concept in spatial planning. Activities that were initially located in public spaces in the city center began to move to local scale service centers, while other activities moved to digital spaces. This condition will affect the spatial organization arrangement and increase the need for ICT infrastructures. The redistribution and limitation of mobility, on the one hand, adds to the burden of local-scale infrastructure but, on the other hand, helps to generate local economies and makes them more evenly distributed throughout the region. The experience of dealing with the COVID-19 pandemic has also triggered policy makers to realize the importance of quality health facilities and reach all areas in terms of surveillance, quarantine facilities, and medical care. This needs to be combined with improving the quality of the urban environment and optimizing smart governance in the process of planning, implementing, and monitoring the space utilization.

In the future, it is necessary to think more about non-natural disaster mitigation for COVID-19. So far, the aspect of disaster mitigation has not been included in the concept of smart city in which it can be a part of the dimension of smart environment. The management for infectious garbage resulted from COVID-19 patients is also a crucial issue which requires attention in the implementation of smart city on the dimension of a smart environment.

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