

# Decreasing urban environment quality and smart environment initiatives

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**Abstract.** Increasing urbanization cannot be avoided and occurs throughout the world, including in Indonesia. Population growth in urban areas has various impacts in almost all dimensions of life. One of the innovative efforts made by the government to overcome these problems is to develop and implement the concept of a smart city, by utilizing information and communication technology (ICT) to provide services to improve the quality of life of the community and maintain the sustainability of the urban environment. This study discusses a literature review on environmental quality degradation which occurs in urban Indonesia as well as initiatives in one of the dimensions of a smart city, namely the smart environment, which can be applied to overcome these environmental problems. The literature review shows that the application of IoT by using sensors and RFID, data cloud, and Twitter has been proven successful in overcoming some environmental problems.

## 1 Introduction

The trend of urban population growth occurred globally in the world, characterized by 55 percent of the population living in cities in 2018 [1]. It is projected that by 2030 the urban population will reach 60 percent, and this trend will continue until 2050 and increase to 68.4 percent of the total global population [6]. The same thing is also happened in Indonesia, namely in 2015 more than half of Indonesia's population inhabited urban areas and it is supposed to increase to 67 percent by 2035 [6].

Urban growth and development make cities have to bear very heavy burdens and slowly raise various problems from various fields of life, one of which is the environment. The extent of the impact on the environment is determined by the consumption pattern and lifestyle of urban population [6]. Urban residents consume massive amounts of energy, water, air and food and overuse land. Changes in consumption pattern have made industry grow rapidly.

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This improvement has had a negative impact on the environment in the form of water, soil and air pollution, in the form of disposal of hazardous and toxic (B3) and non-B3 [6].

Increasing urbanization is one indicator of economic growth. However, the increase in economic growth is also in line with the increase in energy use (fuel and electricity), and will have an impact on the amount of carbon emissions [2]. The increase in energy consumption will increase carbon emission and ultimately have a negative impact on the environment. Apart from that, urbanization also causes the emergence of other environmental problems, such as urban waste problems, air pollution, decreased water quality, and limited green open space.

Urbanization is one of the most important human factors that directly and indirectly causing the changes in land use, leading to the change in landscape patterns [13]. The increase number of cities in Indonesia due to urbanization is mostly caused by urban sprawl, the expansion of cities into the surrounding areas that are not structured and planned [6]. This situation has changed the function of the surrounding areas, which is used to support urban life, into densely populated settlement, or industrial areas that have an impact on environmental sustainability [6]. The decrease in green open space (GOS) is one of the environmental impacts of the land use change. According to Permendagri No. 1 of 2007, the function of GOS in an ecological manner is to improve soil quality, prevent flooding, reduce air pollution and reduce city temperature [14]. Reduced GOS has caused air temperature in urban areas tends to be warmer than in rural areas namely in the range of 0.6 °C-1.3 °C. Furthermore, the reduction of GOS as a water absorption area, increases the likelihood of flooding in urban areas due to changes in water flow pattern. Urban areas usually have high level rainfall. However due to problems in water flow patterns, rainwater continues to flow downstream without being fully absorbed in the process [6].

In large cities, the amount of waste increased exponentially and environmental quality declined significantly. The Indonesian's government has tried to address urban environmental issues since the 1980s, but with no success, because the policy implementation has been poor due to corruption, public agencies' weak commitment to address environmental issues, and local government authorities' low awareness of the issues [15]. However, there is a successful environmental program associated with wastes management namely, ADIPURA, which is one of the most strategic governmental programs, launched by the Ministry of Environment that has been revived since June 2002. This program aims to encourage local authorities to implement good environmental principles in managing the urban environment, so that a clean and green city can be realised [16].

Addressing a number of urban environmental problems requires proper urban planning and management in order to avoid or reduce negative impacts on the urban environment. Besides ADIPURA and other programs, the government also tries to find other solutions to solve environment problems by using the Information and Communication Technology (which is growing rapidly), namely the development of smart cities.

The smart city concept was first used in 1994 by Dameri and Cocchia [5]. This concept was developed as an innovative solution to reduce the negative impact of increasing population in urban areas [6]. Since 2010 the number of publications discussing the concept of smart city has increased significantly [5]. From the various definitions of smart city obtained in the literature study, it can be seen that there is no standard definition yet. This paper will adopt the definition of smart city developed by the International Telecommunication Union (ITU). Smart city is a city concept that innovates by using Information and Communication Technology (ICT) in providing efficient services with the

aim of improving the quality of life, competitiveness while maintaining the sustainability of the city [6].

One of the smart city development programs in Indonesia is the Movement Towards 100 Smart Cities. This movement is a collaboration between the Ministry of Communication and Information, the Ministry of Home Affairs, Bappenas, the Ministry of PUPR, and the Presidential Staff Office (KSP). Through this movement, it is expected that there will be 100 cities and districts that are ready to become smart cities in 2019. This readiness is measured through the availability of a smart city development master plan that defines the steps of the regional government in the future. This readiness can also be seen from the excellent program (quick win) which can be implemented quickly and give an impact to the community [7].

The city / regency selection process uses 4 parameters, namely:

- 1) High Performance City Index (Ministry of Home Affairs),
- 2) Sustainable Cities Index (Bappenas),
- 3) Green City Index (Ministry of PUPR), and
- 4) Regional Financial Capability (KKD).

In May 2017, 25 cities/regencies were selected as the pioneers in the Movement Towards 100 Smart Cities, and 24 of them received award for their success in completing the smart city master plan and the formulation and implementation of excellent programs (quick win). Several cities that received the award were Samarinda, Tangerang, Bandung, Bogor, Makasar, Tomohon, Lombok Timur, Sidoarjo dan Banyuasin [7].

To assess performance of city as smart city there are some indicators and assessment framework provided by European Union Project for Smart City ([www.smart-cities.eu](http://www.smart-cities.eu)). These characteristics are smart economy, smart governance, smart people, smart living, smart mobility and smart environment [12]. Smart environment, in particular, is expected to help solving the environmental problems faced by Indonesian cities.

This study aims to discuss the degradation of environmental quality in Indonesia and smart environment initiatives which can be implemented to overcome these problems. The results of this study are expected to provide input on things that can be implemented in Indonesia to reduce the negative impact of environmental problems due to urbanization.

## **2 Method**

This research was conducted by using literature study method on smart city, especially initiatives related to the smart environment dimension of the smart city concept. Secondary data on environmental degradation in urban Indonesia are also obtained from literature data and data published on the Internet. The literatures discussed in this study are identified by searching the Google Scholar with keywords "smart city" and "smart environment". We then select the literatures based on their relevance. Based on the literature, we identify several environmental problems in urban areas in Indonesia, and then we identify several initiatives in smart environment (from the literature) that some cities in the world have been implemented to overcome environmental problems, that can be used to solve those problems.

### 3 Results and discussion

#### 3.1 Indonesia's environmental problems

Cities in Indonesia experience environmental problems due to urbanization. The results of research [2] conducted in all provinces in Indonesia indicate that urbanization has a significant positive relationship to fuel consumption and total energy consumption. In addition to the increase in fuel consumption, each year electricity consumption per capita in Indonesia has also increased by 0.84 GWh (Giga Watt hour) per capita in 2013 to 1.06 GWh in 2018 [6]. Thus, as urban population increases, the total electricity usage also increases (see Table 1).

**Table 1.** Per capita electricity consumption, 2013–2018 (MWh).

Year	Mega Watt hour (MWh)
2013	0.84
2014	0.88
2015	0.90
2016	0.96
2017	1.02
2018	1.06

Apart from that, urbanization also causes waste problems. Data on the generation of urban waste in the world has increased very rapidly, from 2002, 0.64 kg per person per day increased to about 1.2 kg per person per day in 2010 [6]. Meanwhile, in Indonesia, there was an increase in the volume of waste per day in almost all provincial capitals for the period from 2017 to 2018 [6]. Sustainable Waste Indonesia (WSI) states that Indonesia produces 65 million ton of waste per day, and 15 million ton of the waste pollute the ecosystem and environment because the waste is not handled properly [6]. Table 2 shows the fact that there were eight provincial capitals with the transported waste per day below 60 percent in 2018. The increase in the amount of waste is not only influenced by an increase in population but also by changes in human lifestyles, especially in terms of using plastics as practical packaging. If not handled properly, this plastic waste will continue to increase to 25 percent of total waste in 2030 [6].

**Table 2.** Percentage of transported waste per day in provincial capitals, 2018.

No.	Provincial Capital	Percentage	No.	Provincial Capital	Percentage
1	Mamuju	3.72	18	Pangkal Pinang	75.00
2	Manokwari	39.99	19	Surabaya	75.56
3	Palu	44.74	20	Yogyakarta	75.82
4	Palangkaraya	47.73	21	Balikpapan	77.64
5	Serang	50.97	22	Padang	79.00
6	Gorontalo	51.87	23	Mataram	80.00

7	Jayapura	56.79	24	Banda Aceh	80.13
8	Bengkulu	58.41	25	Bandung	80.56
9	Kendari	62.5	26	Ambon	82.07
10	Pekanbaru	64.71	27	Bandar Lampung	83.30
11	Banjarmasin	69.00	28	Pontianak	84.67
12	Kupang	71.12	29	Medan	84.98
13	Denpasar	72.09	30	Palembang	87.89
14	Tanjung Pinang	72.77	31	Makassar	87.94
15	Manado	73.00	32	Semarang	88.5
16	Jambi	73.42	33	Bulungan	89.47
17	Ternate	73.88	34	DKI Jakarta	95.92

Population growth in urban areas has also resulted in increased industrial, transportation and household activities as well. These three things are the main causes of air pollution in cities that will have an impact on human health and the environment. The results of monitoring in several major cities in Indonesia indicate a decrease in air quality in the last ten years. This can be seen from the increasing number of particles (PM10, PM2.5) and oxidant / ozone (O3) [3].

In addition, according to Law no. 26 of 2007 concerning Spatial Planning which regulates the provision and utilization of green open space (GOS) with a minimum area of 30% of the total area of the city consisting of public GOS and private GOS. This rule is made to ensure the balance of the urban ecosystem. This balance is determined by the balance of the hydrological system, the microclimate and other ecological systems. Those balance conditions can increase the availability of clean air needed by the community and the value of the beauty of the city as well [4]. The increase in population in urban areas has an impact on the increase in the need for land used for industry, transportation and housing. This has led to a very significant downward trend in the quantity of public space, especially green open space in the last 30 years. In big cities such as Jakarta, Surabaya, Medan, and Bandung, the area of green open space has decreased from 35% in the early 1970s to less than 10% in 2010 [4].

### 3.2 Smart environment initiatives

Urban environmental problems marked by a number of quality decreases in a number of indicators can be overcome by the use of information and communication technology (ICT) in the smart city concept. There are several initiatives or projects of smart city that have been developed to address urban environmental problems within the framework of a smart environment. Smart Environment is an environment with knowledge base that develop extra ordinary capabilities to be self-aware, functions at all times, and communicate selectively in real time with end users for a satisfactory way of life, with easy public delivery of services, comfortable mobility, conserve energy, and other natural resources [8]. The following are some of the initiatives discussed in the literature on initiatives of smart environment to solve several environmental problems.

The use of sensors to monitor the level of traffic density helps set traffic lights or the selection of alternative routes for vehicles that will pass through the lane. The way a sensor

system works like this is one of the applications of the Internet of things (IoT) concept which is currently developing rapidly. Several cities in the world such as London, Singapore and Houston have implemented this system and succeeded in reducing the travel time of their citizens significantly. This reduction has positive benefits in increasing productivity, saving energy and improving air quality [9].

The next smart city initiative will take advantage of the benefits of collecting and storing data in the cloud on trash bins in real time. Cloud-based Smart Waste Management (CloudSWAM) manages waste data that has been grouped into three categories, namely organic waste, plastics and bottles and metals so that it can be accessed by all stakeholders including recycling centers to make their own plans [10]. Meanwhile, [9] stated that IoT applications can also be applied in managing waste. The application of IoT using RFID (Radio Frequency Identification Devices) technology in the recycling industry has been researched by the European Commission and has proven successfully in reducing collection costs by up to 40 percent. Two cities in the United States, Cleveland and Cincinnati, also benefit from IoT and RFID. Waste management in these two cities places an RFID tag on each trash bin and recycling bins so that it is known who owns and where he lives. When the waste will be transported by the truck, the reader will scan this RFID tag and from the data obtained, it can be seen how long it takes for truck drivers to pick up waste from house to house so that it can be more productive. In addition, it is also possible to know whose house is recycling or throwing waste excessively. As a result, in Cleveland 42 percent of the waste collected can be recycled and sold for US \$ 5.5 million and in Cincinnati the volume of recycling has increased by 49 percent, household waste has decreased by 17 percent and operating costs have decreased by 13 percent.

To solve the problem of air pollution, [11] develops an IoT-based smart air quality monitoring system called LoRaWAN (Long Range Wide Area Network). Previously used conventional systems required complex and well-established sensor equipment with high levels of precision and reliability, but required enormous acquisition and maintenance costs. While LoRaWAN uses low-cost sensors and long-range wireless communication technology (LoRa) which has better coverage and power usage. This air quality monitoring system will measure four parameters of air quality, namely, temperature, humidity, dust and CO<sub>2</sub> levels.

The implementation of smart environment has also been conducted to overcome the problem of limited green open space. Smart city has been part of Bandung's (Indonesia) strategic planning period 2013-2018 to find alternative solutions to some environmental problems. One of the smart environment programs being implemented is building a thematic park as an effort to increase green open space. According to Law no. 26 of 2007 concerning Spatial Planning, the area of green open space (GOS) compared to the total area of the city minimum is 30 percent. In 2011, Bandung city owned 1,910.49 hectares of green open space or 11.43 percent are of Bandung. Bandung city government has overcome the limited land space for adding green open space by building a number of thematic parks with an interesting concept and planting trees on pedestrian paths and empty areas under flyovers. This solution comes as a result of the collaboration of the city government and input from Bandung residents conveyed through social media Twitter [12].

## **4 Conclusion**

The increase in population in urban areas raises various problems which result in a decrease in the quality of ecosystems or the environment in various parts of the world, including cities

in Indonesia. This study presents a literature review on environmental degradation in urban Indonesia as well as initiatives in the framework of a smart environment that can be applied to overcome these problems. The results of the literature review show that there has been a significant increase in energy consumption, an increase in waste, a decrease in air quality and a decrease in green open space in urban Indonesia. To overcome this, various efforts can be made by the government, one of which is by developing a smart city concept that focuses on addressing environmental problems. Our literature study shows that the concept of smart city (especially smart environment) with various initiatives has succeeded in utilizing information and communication technology (ICT) applications such as IoT (Internet of Things) applications in overcoming problems with energy use, waste management and air pollution. Apart from using IoT applications, waste management problems can also be overcome by utilizing cloud data applications. The last one, social media Twitter plays a role in conveying people's ideas to increase green open space.

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