

PAPER • OPEN ACCESS

## Preliminary Study of Smart Regional Waste Recycling in Boyolali, Central Java, Indonesia

To cite this article: Maryono and K Seruyaningsyas 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **248** 012051

View the [article online](#) for updates and enhancements.

# Preliminary Study of Smart Regional Waste Recycling in Boyolali, Central Java, Indonesia

Maryono<sup>1,2</sup> and K Seruyanings<sup>2</sup>

<sup>1</sup>Department of Urban and Regional Planning Faculty Engineering Diponegoro University

<sup>2</sup>Center for Green Infrastructure Resilience and Development (C-Greinde), Master Program of Environmental Science, School of Postgraduate, Diponegoro University Jl.Prof.H.Soedarto, S.H.Tembalang, Kota Semarang, Jawa Tengah 50275 – Indonesia

[m.maryono@undip.ac.id](mailto:m.maryono@undip.ac.id)

**Abstract.** Based on its functional aspects, the area is divided into two, namely urban and rural areas. Problems related to solid waste are not spared from that areas. However, problem-solving solutions cannot be generalized between the two areas because of the different characteristics of the community. This study took place in Boyolali District, Central Java, consisting of 192 rural areas and 75 urban areas. Judging from the characteristics of the population, most people in rural areas do not consider the waste management system that is already important. The main reason is the mindset of the community and applicable waste retribution. Rural communities prefer to burn all their waste on their own land rather than having to pay for waste transportation or recycle their waste. Unlike the case with people in urban areas who have followed the pattern of solid waste management carried out by the government. In addition, there are several community groups in urban areas that have begun to actively recycle waste even its still use conventional technology. Therefore, the application of smart waste management, especially smart waste recycling were already applied in districts which closed to the capital region.

## 1. Introduction

Increasing population from year to year and limited natural resources make city management more complex. This condition requires the Regional Government to be able to maximize the potential of its resources and minimize the obstacles or problems faced. The concept of smart city which is a big issue in big cities around the world encourages active role and community participation in city management using a citizen centric approach so that there is a more dynamic and close interaction between citizens and service providers, in this case Local government. This two-way interaction will continue to evolve and process so that in the future the city will become a comfortable place to live and be resilient in responding to new changes and challenges more quickly. One of the dimension of smart city is smart environment.

Waste generation is one of the indicator in smart environment. With rapid urbanization and industrialization, city is facing multichallenges in environment case. Including resource depletion, environmental pollution and climate change mitigation. In addition, the increasing quantity of municipal solid waste (MSW) is problematic due to the limited availability of land for new landfill sites. Therefore, city need good waste generation and it is essential to promote the reutilization of recyclable wastes,



which can simultaneously respond to the issues of limited landfill space, environmental pollution, and natural resource depletion. The government in Indonesia regards recycling as one of the way to reduce waste with the aiming for recycling rate of 30% in municipal solid waste by 2025.

This research was conducted in Boyolali which is a region that has rapid development, with 75 urban areas and 192 rural areas. Boyolali Regency included in the 100 smart city program in Indonesia. Waste generation in Boyolali is still limited to urban areas, while rural areas use traditional methods by landfilling in their yard. The composition of waste in Boyolali Regency consists of organic waste, plastic waste, paper, metal, cloth, wood, glass and B3 (Toxic Hazardous Materials). For the percentage of each type of waste component, that is for organic waste has the highest percentage of 53.84%, then the second most is plastic waste as much as 20.89%, the paper waste is 13.30%, textile waste 1.57%, wood waste 1.80%, metal waste 1.10%, rubber waste 1.05%, hazardous waste is 2.74%, residual waste 2.72% and the lowest percentage is glass waste with a percentage of 0.98%. Recycling program in Boyolali still for paper and plastic component.

Based upon these studies, the purpose of this paper is to define the level of the application of the Smart Waste Recycling concept that has been carried out by utilizing the technology currently available. In order to test its applicability, a case study approach was employed, which can reflect more practical and geographical characteristics.

## **2. Data and Method**

### *2.1. Data*

The source of waste contained in Boyolali Regency consists of various types, namely residential, commercial, public facilities, schools, hospitals, health centers, markets, and industries. The biggest source of garbage comes from settlements, for sources of commercial waste comes from offices, shops, restaurants, and recreational areas, while the sources of waste from public facilities are roads and parks. Based on government regulation, there are aspects in waste management which indicators in recycling system:

1. Regulation

Regulation is an important aspect in waste management activities. The regulation on waste management in Boyolali Regency is based on Boyolali Regulation No. 13 of 2013 concerning Waste Management that stated Regional Government is responsible for ensuring the implementation of good and environmentally sound waste management in the Region. In Boyolali regulation also stated about recycling system.

2. Institutional

Waste management in Boyolali Regency is carried out by the Environmental Agency, in Waste Management Sector, Hazardous and Toxic Waste, and Landscaping which is specifically carried out by the Waste Management section. Recycling system in Boyolali manage by organization in every districts and will be responsible to Environmental Agency.

3. Financial

The financial system or financing in waste management in Boyolali Regency comes from APBN, APBD, retribution and CSR from the company in Boyolali Regency.

4. Public participation

One of the important things in waste management is community participation, because waste is the result of community activities. The participation of the community in Boyolali District is shown by the presence of 3R TPS and waste banks in several districts.

5. Technical operation

Waste management is supported by technical-technological aspects so that it can run well. The sub-technical-technological system in solid waste management starts from sorting and waste bin in the source, waste collection, waste transportation, waste treatment and final disposal.

## 2.2. Method

The identification of smart waste recycling is done by looking at the development of the waste management system in the relevant study area. The data used is secondary data obtained from the publication of related agencies through the internet. This data is an indicator used in measuring smart waste recycling which refers to SNI 3242:2008, namely the operational technical aspects, aspects of deception, aspects of community participation, financing aspects, and institutional aspects. The following is a table of smart waste recycling assessment indicators are:

**Table 1.1** Indicators of Smart Waste Recycling

| No | Aspects                 |                                        | Indicators                   |
|----|-------------------------|----------------------------------------|------------------------------|
| 1  | <b>Waste Generation</b> |                                        | Type of Waste Generation     |
| 2  |                         |                                        | Mass of Waste Generation     |
| 3  | <b>Waste Management</b> | <b>Operational Technical Aspects</b>   | Waste Bin                    |
| 4  |                         |                                        | Waste Collection             |
| 5  |                         |                                        | Waste Transport              |
| 6  |                         |                                        | Waste Treatment              |
| 7  |                         |                                        | Final Disposal               |
| 8  |                         | <b>Regulatory Aspects</b>              | Regulation of recycling      |
| 9  |                         | <b>Community Participation Aspects</b> | Public campaign of Recycling |
| 10 |                         |                                        | Waste Bank                   |
| 11 |                         | <b>Financing Aspects</b>               | Budget for recycling         |
| 12 |                         | <b>Institutional Aspect</b>            | Recycling Program            |
| 13 | <b>Recycled waste</b>   |                                        | Type of Waste Recycling      |
| 14 |                         |                                        | Mass of Waste Recycling      |

The data obtained then used to determine the value of each indicator by scoring range with a value of 0 to 2, for example: 1). Value 0: no data is published on the website; 2). Value 1: available data that is published but incomplete data; 3). 2: available data that has been published on the website. Then the value of each indicator is summed and produces the total score of each indicator. The total score on the indicators described is then presented in the form of maps using ArcGis 10.6 Software. The software functions to find out the difference in data availability regarding waste management in each sub-district in Boyolali Regency.

## 3. Results and Discussion

### 3.1. Results

**3.1.1 Smart recycling and waste generation.** Waste generation has 2 indicators, there are type of waste generation and mass of waste generation. Type of waste generation in all of districts are same with high component of organic, then plastic, and paper. Information about type of waste generation and mass of waste can be access in website of Environment Agency.

**3.1.2 Smart recycling and waste management.** Waste management has 5 indicators, since waste bin, waste collecting, waste transport, waste treatment and final disposal. Information about waste

management in Boyolali already published in website of Enviroment Agency but not all complete to all of districts. There are only Boyolali, Teras, Mojosongo, Ngemplak, and Musuk.

**3.1.3 Smart recycling and recyled waste.** Smart recycling in Boyolali just in several districts. There are Mojosongo, Teras, Ngemplak, and Musuk. Information about recyled waste can be access from the internet.

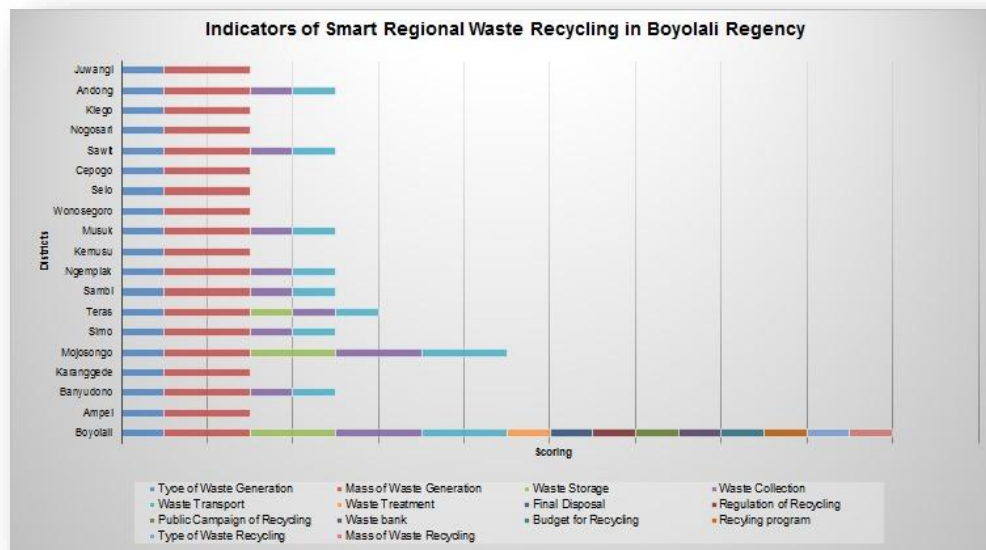


**Figure 1.** Diagram of Indicators Smart Regional Waste Recycling in Boyolali

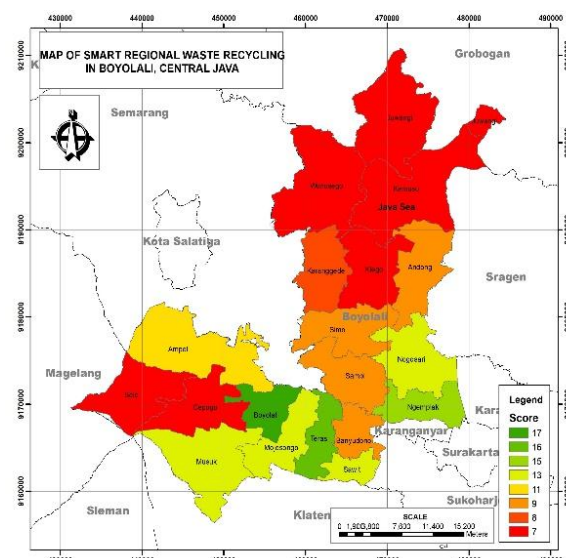


**Figure 2.** Mapping of Smart Recycling in Boyolali

Based on the map above, the area that has low smart recycling is gradation of red while the area that has high smart recycle is gradation of green. Area with high smart recycling is around the capital region. More far from the capital region, lower in smart recycling. So that in rural area smart recycling is still not equally in each districts.

#### 4. Conclusion

Based on the results, recycling is one of the solutions in smart waste management. Therefore, smart waste management is an implementation in a smart city. Smart waste recycling in Boyolali is still not equally in all of districts. Only districts which closed to the capital city has smart recycling waste.

#### 5. References

- [1] Caragliu, A., & Del, C. F. (2018). Technological Forecasting & Social Change Smart innovative cities : The impact of Smart City policies on urban innovation. *Technological Forecasting & Social Change*, (December 2017), 1–11.
- [2] Fujii, M., Fujita, T., Chen, X., Ohnishi, S., & Yamaguchi, N. (2012a). Resources , Conservation and Recycling Smart recycling of organic solid wastes in an environmentally sustainable society. *"Resources, Conservation & Recycling,"* 63, 1–8.
- [3] Fujii, M., Fujita, T., Chen, X., Ohnishi, S., & Yamaguchi, N. (2012b). Resources , Conservation and Recycling Smart recycling of organic solid wastes in an environmentally sustainable society, 63, 1–8.
- [4] Fujii, M., Fujita, T., Ohnishi, S., Yamaguchi, N., Yong, G., & Park, H. (2014). Regional and temporal simulation of a smart recycling system for municipal organic solid wastes, 78, 208–215.
- [5] Wang, H., Han, H., Liu, T., Tian, X., Xu, M., Liu, Y., ... Gu, Y. (2018). Resources , Conservation & Recycling " Internet + " recyclable resources : A new recycling mode in China. *Resources, Conservation & Recycling*, 134(March), 44–47.
- [6] Xiao, S., Dong, H., Geng, Y., & Brander, M. (2018). Resources , Conservation & Recycling An overview of China ' s recyclable waste recycling and recommendations for integrated solutions, 134(March), 112–120.
- [7] Sistem Informasi Pengelolaan Sampah Nasional (2018). Retrieved from <http://sipsn.menlhk.go.id/>

#### Acknowledgments

This research is funded by the Directorate of Research and Community Services, Ministry of Research, Technology and Higher Education for year 2018 with contract number 101-147/UN7.P4.3/PP/2018. Partly, this research/article's publication is supported by the United States Agency for International Development (USAID) through the Sustainable Higher Education Research Alliance (SHERA) program for Universitas Indonesia's Scientific Modelling, Application Research and Training for City-centered Innovation and Technology (SMART CITY) Project, Grant #AID-497-A-1600004, Sub Grant #IIE-00000078-UI-1.

This article is presented at the International Conference on Smart City Innovation 2018 that supported by the United States Agency for International Development (USAID) through the Sustainable Higher Education Research Alliance (SHERA) Program for Universitas Indonesia's Scientific Modeling, Application, Research and Training for City-centered Innovation and Technology (SMART CITY) Project, Grant #AID-497-A-1600004, Sub Grant #IIE-00000078-UI-1