



Development of Information Technology-Based Waste Management in Probolinggo City

Aman Suryaman¹; Soemarno²; Aulanni'am³

¹ Doctoral Program of Environmental Science, Brawijaya University, Malang, Indonesia

² Department of Soil Science, Faculty of Agriculture, Brawijaya University, Malang, Indonesia

³ Department of Biomedical, Faculty of Veterinary, Brawijaya University, Malang, Indonesia

Email: Am4n.75@gmail.com

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Abstract

Reducing the rate of population growth is a less efficient strategy to minimize garbage output than the importance of each citizen participating in the development of sustainable waste management. Effective reduction can be achieved by increasing community involvement as the main source of waste. The use of information technology (Internet) in terms of waste services is one example of sustainable waste management. The Internet of Things (IoT) environment enables the perception, acquisition, processing, and transmission of environmental information. This study aims to develop waste management in Probolinggo City with the involvement of information technology-based community participation. This research using a qualitative descriptive analysis method, Probolinggo City can determine the extent of community participation in trash management based on information technology. The level of information technology-based community participation will have a significant impact on the development of sustainable waste management in Probolinggo City with the development of a Smart Environment through the SIEMAK KASRAKAS application, the benefits of which are felt by the community, according to research on engineering innovations in waste management. Therefore, a commitment is required from the Environmental Service (DLH) and the community to carry out waste management tasks using information technology, in order to provide a clean, healthy, and comfortable environment that complies with environmental regulations.

Keywords: *Waste Management; Information Technology; Environmental Regulations*

Introduction

Waste management is a methodical, all-encompassing, and sustainable activity that includes handling and reducing waste. The principles of responsibility, sustainability, benefit, justice, awareness, togetherness, safety, security, and economic value are all used to guide waste management. These

principles are also used to guide other actions such as recycling and composting. Garbage management strives to turn waste into a resource while also enhancing public health and environmental quality. Although operationally its administration can work with business entities, waste organizations, and community groups active in the waste sector, this has legal ramifications that the government is the authorized and accountable entity in the field of waste management (Yuliana and Haswindy, 2017).

For the sake of protecting public health and reducing environmental contamination, proper waste management should take precedence. Waste management and awareness are new ideas in developing nations. Appropriate waste management is essential for preserving the environment and promoting sustainable development. However, waste management has gotten worse in underdeveloped nations due to a lack of infrastructure and unsustainable practices, which causes environmental degradation. In open dumpsites, waste is dumped and picked up in the open, posing major health dangers such chronic illnesses and skin infections. Due to the high population density in slum areas, the situation worsens. It is abundantly obvious that improper waste management and environmental and health problems are linked (Sohag & Podder, 2020).

An IoT-based wireless solid waste management system for smart cities was proposed by Krishna et al., (2017) that aids municipal corporations in continuous remote monitoring of the garbage level of dustbins over a web server. It minimizes the cost and saves time. When the trash can is full, a message using GSM is placed in the trash can to notify the appropriate authority. The authority then dispatches cars to collect rubbish at a predetermined site. The primary goal of the proposed project is to make sure that IoT-based apps for effectively collecting and managing waste are improved in order to create a smart city. An integrated waste management system that uses smart trash cans that are equipped with a network of sensors was proposed by Hitesh et al., (2017). The device also permits the transfer of data that shows the amount of waste in the bin in real-time. Vinoth et al., (2017) proposal for an IoT-based solution for a smart waste management system uses sensors to help keep track of the amount of rubbish in dustbins. To integrate the entire system, an android-based application is being created. Additionally, it offers details about the waste accumulation in various areas' trash cans.

The creation of smart cities requires both top-down and bottom-up cooperation. By incorporating all parties to produce a clean and sustainable environment, the implementation of smart cities, particularly in the smart environment element, substantially contributes to finding solutions to the waste problem. The community's efforts to build a smart city, which is a connected green metropolis where all facets of life are integrated and intelligent communities have sustainable ecosystems, environmental advances, and social advancements, are aided by a clean and comfortable atmosphere. In carrying out its primary duties and responsibilities, the Probolinggo City Government seeks to implement waste management using a variety of models, one of which is sustainable environmental management, particularly the growth of community waste management participation based on information technology.

Theoretical Framework

Society Participation

The community's overall participation in waste management has thus far been restricted to disposal; it is not yet at the level of management where it can be reused. This situation shows that there is still a lack of public understanding of waste management, the community does not yet view waste as a resource, the community is not aware of the various regulations or guidelines in waste management, and the government tends to treat the community as an object in development rather than involving it in the waste management process (Yuliana et al., 2017). The community should be the focus of development in terms of planning, implementation, and supervision on the part of the government.

A person engages in community activities outside of work by joining social groups and participating in them (Makhmudi and Muktiali, 2018). A development program requires community involvement since the effectiveness of the program depends on the community's involvement in its administration. Additionally, community engagement entails community involvement in the development planning process, beginning with problem analysis, solution consideration, confidence building, and independent decision-making regarding potential solutions. In developed nations, community involvement is frequently employed as a successful method of decision-making, public project implementation, and governance (Xie et al., 2017).

Civil society actors may nonetheless try to influence negotiations by persuading government representatives to accept their perspective (Holsti, 1988). They have developed activities to increase their chances of influencing intergovernmental policymaking, using participatory spaces both inside and outside negotiating hubs. I understand participatory space as an arena for the communicative generation of public preferences and a vehicle for marshaling those preferences as a social force capable of influencing the political field (Fraser, 2007). Inside negotiating hubs, civil society actors can voice their opinion in oral or written interventions, in formal or informal settings. Formal settings include speaking rights during the negotiating sessions, face-to-face consultations with governments and the co-chairs of the negotiations, and online consultations. Informal settings include side events and bilateral or multilateral meetings with governments and/or the co-chairs. For governments, the benefits of considering civil society contributions are important and include knowledge provision and political support. Yet when governments remain unresponsive to their contributions, civil society actors will also aim to pressure governments by organizing activities to influence intergovernmental policymaking from outside negotiating hubs, such as mass protests, campaigning, strategic use of, and alliances with media to raise awareness and influence the publics (Rietig, 2011).

Academic research has been prolific in assessing the roles of civil society actors and the influence of their activities as a whole in intergovernmental negotiations on environmental sustainability, focusing on a specific issue area negotiated in a global event (Brosius and Campbell, 2010; Campbell et al., 2014; Corson et al., 2015) or taking a comparative approach across issue areas and policy arenas (Betsill and Corell, 2008; Chasek, 2001; Fisher and Green, 2004; Princen and Finger, 2013). Other studies focused on “moments of influence” and the relational maneuvers employed by civil society actors to shape negotiations (Witter et al., 2015). Drawing on scholars that identified, through collaborative event ethnography, the setting of negotiations as a key aspect in explaining the dynamics and outcomes of negotiations (Campbell et al., 2014), I focus on participatory spaces as specific settings in which civil society engages inside negotiating hubs to shape global sustainability governance.

Information Technology Use in Community-Based Waste Management

Waste owners will find it simpler to collect waste thanks to information technology so that the manager can appropriately treat it. Additionally, it can promote a sense of accountability for environmental protection and appropriate waste management. The way this information technology operates, according to Sa'diyah et al., (2020), is that the waste owner enters his waste information, which is then sent to the admin for information and input. According to Lee et al. (2014), the infrastructure for information technology is crucial in promoting economic growth. Information technology platforms like personal computers, mobile devices, the internet, databases, and others play a significant role in the company. The three contributions made by information technology platforms, according to Piatkowski (2003), that have an effect on organizational performance are: (1) providing feasibility in business aspects; (2) providing more accurate, reliable, and up-to-date information; and (3) providing solutions to common issues faced by businesses in their daily operations. One can easily follow the evolution.

A wide range of applications and confusion have resulted from misconceptions around community-based monitoring and other related concepts, such as citizen science, volunteer monitoring, government- and other institution-led programs (Overdeest et al., 2004). Community-based monitoring has been defined in a number of ways throughout the years, but none of them have gained widespread acceptance. We must look into how the concept of community-based monitoring has generally been interpreted and used in the literature before we can describe it. Such an investigation demonstrates that the concept of community-based monitoring has been poorly understood due to several connotations. To comprehend the large range of definitions and classify them into the proper categories, we divide its definition into two views.

The first viewpoint focuses on the philosophy guiding community participation, whereas the second is based on its methodological elements. Most authors characterize community-based monitoring philosophically in terms of the crucial function that the community plays (McKay and Johnson, 2017). The term "community" can refer to a specific area or territory, a collection of residents in a neighborhood, town, or city, or the nature or quality of interactions between different social groupings. This second description can apply to certain kinds of groups formed around common talents or hobbies, like the divers' community (Monk et al., 2008).

Therefore, the term "community" in community-based monitoring can refer to a group of people who share shared interests or talents as well as a group of people who live in a certain location. The philosophical viewpoint acknowledges the crucial function that involvement empowerment plays. The word "participation" is frequently used to refer to nearly anything that involves people, but not necessarily their empowerment (Cornwall, 2008). However, via community involvement, empowerment plays a vital role in community-based monitoring (Bliss et al., 2001; McKay and Johnson, 2017). The collaboration that results from face-to-face discussions allows for the division of authority among the community's members. This sense of shared responsibility encourages local leadership and stewardship within the community.

In the long run, this cooperative strategy has a great potential for adaptive management since it promotes the transmission of both the traditional or local knowledge of community members and the scientific information of researchers (Johnson et al., 2013). The terms collaborative and transformational governance can be used to express a philosophical outlook that permits community involvement in community-based monitoring and decision-making processes not just as participants but also as collaborators (Lawrence, 2006). Thus, the philosophical viewpoint emphasizes community empowerment as local communities working with the government, non-governmental organizations, and scholars to identify suitable answers to community problems.

Research Methodology

This study employs a qualitative research methodology, whereby a team of researchers in the field of social sciences, including environmental sciences, frequently use and carry out qualitative research as a scientific method. The goal of qualitative research is to increase knowledge by discovering and comprehending the world more thoroughly. Because qualitative research is holistic (holistic), it sees the subject or object of the study as a dynamic thing that is the product of the formation of ideas and interpretations of the occurrences that are being observed (Hermawan, 2019).

Its goal is to develop and design strategies to increase community participation in waste management in order to create a sustainable smart environment. The research is phenomenological in nature and uses waste management information technology engineering that involves human resources and community behavior. This study was done to find out how society is doing right now in terms of

waste management, information technology use, and community involvement. Finding out the actual and anticipated conditions of community participation in waste management using information technology is a benefit of this research that goes beyond addressing the objectives (a case study of the development of a smart environment in the city of Probolinggo).

Informants served as the study's data sources. The informant's position enables them to respond to the researcher's questions. Archives are later data, documents, or formal records that may be written materials or other types of recordkeeping. The information used in this study was gathered through interviews with waste managers, community leaders, stakeholders, and members of the waste management community. Participatory Rapid Appraisal is the information gathering technique used in this study to operationally observe the evolution of technology-based waste management (PRA).

Discussion

The role of information technology in waste management operations is very important to increase the ability of ICT human resources (HR), starting from skills and knowledge, planning, operation, maintenance, and supervision, as well as improving ICT capabilities in the end, which will produce output that is very beneficial for humans as individuals as well as for all sectors of life, including waste management. For this reason, an effort is needed from the government, in this case the city government of Probolinggo through the Office of Communication and Information in synergy with the Office of the Environment, to be able to reduce waste problems by utilizing information technology, namely building a mobile application that integrates information features, education, and waste management services in Probolinggo City.

With this application, the aim is to integrate, synchronize, and synergize programs, activities, and information on waste management in Probolinggo City and convey it to the community through an Android-based application. Against the background of the problems previously stated, an application is needed as a supporting tool to be able to convey information related to waste management quickly, effectively, and efficiently and to support the management of waste management in Probolinggo City. The application that will be provided is called SIEMAK (Management Information and Education System) KASRAKAS, which is an application based on Android apps in an online network that integrates information, education, and waste management services in Probolinggo City and can be accessed by the public. The purpose of the SIEMAK application procurement activity is to provide an information technology-based supporting tool for waste management in Probolinggo City. From the results and discussion regarding the need for the development of information technology-based community participation in waste management in the City of Probolinggo, it can be argued:

1. The use of information technology by the City Government of Probolinggo through the SIEMAK KASRAKAS application, which was developed in the context of delivering information and education, is expected to facilitate services to the community regarding waste management, even though in practice there are obstacles that can become obstacles in information technology-based waste management.
2. Waste management in the people of Probolinggo City today, especially in terms of reducing waste, has used 3R (Reduce, Reuse, Recycle) and in accordance with environmental rules will have an impact ecologically, educatively, effectively, efficiently, economically and social institutions that deal with management issues waste in Probolinggo City.
3. SIEMAK KASRAKAS is an application system that is integrated between waste managers and household waste producers specifically and the application content needs to be updated so that it can serve user needs

The Smart Environment program is a development of the waste management program in Probolinggo City. In order to maximize information technology-based community participation in waste management in Probolinggo City, implications and strategies are needed in preparing the Smart City Masterplan. The purpose of preparing this Smart City Master Plan is to provide references and guidelines for development planning and smart city development in the form of program initiatives and a roadmap for regional apparatus organizations in Probolinggo City.

The preparation of the Smart City Master Plan also aims to provide directions for accelerating Probolinggo City's development strategies, policies, and programs that have been contained in Development Planning Documents such as the Medium-Term Development Plan (RPJM), Long-Term Development Plan (RPJP), and Regional Spatial Plan (RTRW).) Probolinggo City with a planning approach of six (six) smart city pillars, namely smart governance, smart branding, smart economy, smart living, smart society, and smart environment. Smart cities are expected to provide solutions that generally aim to:

1. Improving the quality of life of the community;
2. Improving the community's economy; and Information technology in the city Probolinggo and the spirit of building ICT led to the vision of a smart city for Probolinggo City, namely: a smart, efficient, transparent, participatory, impressive, and responsible service city.

To support the vision of a smart city in Probolinggo City, information and communication technology (ICT) infrastructure must be built.

- a. A 3G or 4G network covers the whole area.
- b. 6 (six) BTS wireless network backbones
- c. Bandwidth capacity of 400 MBPS up to and dedicated to 100 MBPS.
- d. Data center and Data Recovery Center (DRC).
- e. There is a server room with a capacity of 8 servers.
- f. Hot spots for the public in several public facilities
- g. CCTV installed as many as 28 units
- h. The electricity supply support system uses an additional power supply based on a UPS (uninterruptible power supply).

In order for efforts to increase information technology-based community participation in waste management in Probolinggo City to run optimally in accordance with the smart environment program, the SIEMAK KASRAKAS application program was created. The SIEMAK KASRAKAS application means Community Information and Education System, while KASRAKAS is an acronym for garbage in Maduranese. Since this application was developed, it has not been optimally implemented for stakeholders supporting waste management. The role and participation of the information technology-based community is very likely to be an inhibiting or supporting factor for sustainable waste management. Participation is a process and to differentiate the process, ladders/levels of participation are made. The theory about the level of participation is used as the basis for weighting the benchmark level of community participation in information technology-based waste management in Probolinggo City. The concept of the level of participation from various theories and experiences in the field of participatory planning.

Conclusion

Researchers found that waste management in accordance with environmental principles is expected to harmonize ecological, social, and economic factors in order to realize community welfare.

This conclusion is supported by studies on waste management engineering solutions based on community engagement and information technology in Probolinggo City. According to research on engineering innovations in waste management, the degree of information technology-based community participation will have a significant impact on the growth of sustainable waste management in Probolinggo City with the development of a Smart Environment through the SIEMAK KASRAKAS application, the advantages of which are felt by the community. In order to offer a tidy, healthy, and cozy environment that complies with environmental rules, a commitment is needed from the Environmental Service (DLH) and the community to carry out waste management duties utilizing information technology.

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