Waste Management Design for Green Campus

N. Lestari, K. Abimanyu

***Abstract*— Academic community activities on campus certainly produce various types of waste, especially paper, plastic bottles, batteries, and various other types of waste. 18% of all criteria Green Campus Criteria according to UI Greenmetric is waste management. Based on the criteria, the campus needs to be focused on the waste management system such as waste segregation, pre-recycling, recycling, organic waste management, and policies on waste management at the university governance to reduce the use of paper and plastic packaging. Technology can be used to improve waste management systems, preparation for recycling waste by crushing it before recycling, collection and transfer of waste to landfill, or organic waste composers around the campus. Various sensors and alarm systems are integrated into waste collection equipment and can be connected through the Internet of Things (IoT) system to be monitored by the authorities. Through the design of a technology-based waste management system, it is hoped that it can reduce waste production for the environment and can increase Green Campus rank which certainly provides positive benefits for the environment, the academic community, and society.**

***Index Terms*—Green Campus, IoT, Smart System, Waste Management**

I. Introduction

WASTE is residue from human activities, a lot of waste is produced at the university such as paper, plastic food packaging, batteries, food scraps, etc. In June 1992, the United Nations Conference on Environment and Development (the "Earth Summit") was held in Rio de Janeiro, Brazil. Following the conference, several international agreements have been reached to progress towards sustainable development

To move to a socioeconomic system based on "sustainable consumption and production" the creation of a good material cycle society is very important. This will restrain the consumption of natural resources, increase resource productivity and lower environmental impact. The key to building such a community lies in the promotion of 3Rs (Reduction of solid waste generation, Reuse of resources and products, and Recycling).
Attaching technology to a product can help the integration of various devices with the internet network. IoT is a growing trend and based on various researches to provide new functions, research on waste management in the campus environment is carried out.

II. Literature Review

Smart Trash Bin, can be implemented using sensors to detect the maximum volume of a bin. In this condition, the trash can communicates using a GSM module with a data centre so that it can be emptied and transferred to a larger shelter [1]

The basic form of waste management consists of generation, collection, separation, treatment, disposal, recycling. From this, it can have an influence on the environment and also stakeholders. Cloud-based Smart waste can be used as an alternative to streamline waste management and can even maximize the efficiency of waste mitigation routes from around campus [2]

Beginning with IoT for waste management using sensors and manual warning systems, in the future Artificial Intelligence system can be applied by analysing algorithms from data collected on the system [2]

To trigger the motivation of the academic community to work together to build a green campus, gamification can be done in the form of awarding points or badge systems for systems that are assisted with technology. Adding gamification to the management of waste management, especially to make this management process a successful learning process carried out by students, can be done by giving rewards to students who contribute to sorting out waste either impacting on academic grades or others. Because based on research provides rewards as a form of positive reinforcement. [3] [4]

III. System Design

Fig. 1 shows that this project used to put sensors as an input system and then process it with a controller to be communicated to the data centre so that the next process can be carried out both by machines and by humans. All of the system development need to be an innovative technology with affordable price.

There is integration between several smart systems that are connected to the network. Several methods of waste collection with sustainable development models

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such as smart trash bin, automatic waste sorting, automatic transfer machine, and pre-recycle systems. Then this waste collection data will be collected in the data center and then can be distributed to landfills or recycling sites.

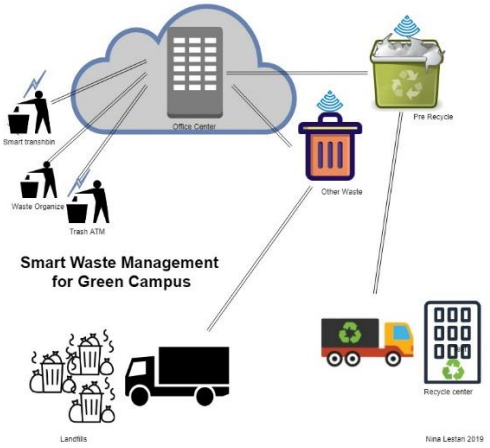

Fig. 1. Waste Management System Design

A. *Smart Trash Bin*

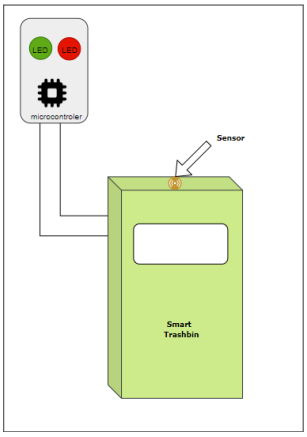

Fig. 2 Smart Trash Bin Design

Fig. **2** system using sensors to detect garbage in the trash bin with ultrasonic or infrared sensors. Then using a microcontroller to be able to process sensor data, if the trash has reached its maximum capacity, the controller will give an order to send a warning to the waste management office as a data centre so that the trash bin can be emptied by officers

B. *Automatic Waste Sorting Machine*

Fig. **3** is designed using a weight sensor so that it can detect the waste type which put on the machine. Then use a motor to be able to separate waste into each garbage classification box. The advantage of this tool is that it can accommodate the habit of sorting waste before disposing of it that has not been done properly. The controller installed on this device so that it will also be easier for sending data to the data centre.

On this machine, the concept of smart trash bin can be integrated and get new functions that are more complete.

C. *Automatic Transfer Machine for Waste*

Various functions can be developed on this machine, automatic waste sorting, pre-recycling, gamification, and data collection. RFID and other biometrics will be used to verify the machine user ID and the data will be sent to the data center to be processed later

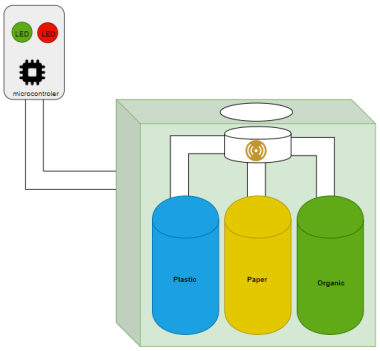

Fig. 3. Automatic Waste Sorting Machine

D. *Data Center*

Assumed as a center for managing data obtained from each waste collection machine that can also communicate with stakeholders, data processing is carried out in the data center and the development of a user interface to facilitate monitoring of the officer. This is also where data processing for the initial analysis of the campus waste mitigation algorithm can be carried out. So that AI becomes possible in this system.

E. *Gamification*

Student at university can be assumed as an adult learner who has characteristics as a self-motivational person. To reach the self-motivation people need the reinforcement, either positive or negative. As an educational institution, positive reinforcement is better to implement. Badge or point reward can be given to the student or another person who use the machine. Gamification system will increase student interest to use the machine. Here will need analysis of user and game design with many processing data and system integration with the big data in university.

IV. Conclusion and Future Work

To create products that have good capability and reliability, a gradual process and continuous improvement are needed. Waste management in the campus environment can be a prototype for a smart city in waste management. During the development and improvement process, it is also expected to be able to contribute to changes in the habits of the academic community in the campus environment in disposing of trash even to the point of making a positive contribution to the environment in general.

Future work from this is the development of product prototypes that are following the latest technological developments at affordable prices with good product quality so that it can be used by the public

V. REFERENCES

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