

A Smart Green Public Spaces Management Model for Indonesian Higher Education Institutions

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ABSTRACT

A study on designing a smart green campus model in the context of resource-limited higher education institutions was conducted. The study was recommended as the requirements for green campus operation for sustainable development is increasing. A number of initiatives in implementing environmental friendly public spaces management especially at Indonesian higher education institutions have been in place. However, there is still a lack of available models that can be referenced especially for resource-limited institutions in the tropical environment. Therefore, this study proposes a model on smart green public spaces management model particularly for higher education institutions in the tropical environment. The model was developed using an "adopt-and-modify" approach from a referenced Japanese university. A survey from a sample of Indonesian higher education institution shows that respondents are good in energy-saving and waste management perceptions. However, the observation made during the data collection has shown that the real practice of energy and waste management in the higher education environment were still poor.

Key Words: Smart Building, Green Campus, Higher Education.

1. INTRODUCTION

The main objective of this research is the development of a smart green campus model towards environmental sustainability in the Indonesian Higher Education (IHE) institutions. As found in a reference, a smart technology can be used as the driver for overcoming environmental issues [1]. A research conducted by [1] has highlighted a four main themes of the smart green campus namely: (i) smart learning and (ii) smart sharing in the field of education and research, (iii) smart buildings and (iv) smart transport in the operations of the university. In addition, the US Green Building Council (USGBC) has developed a roadmap to a green campus and pointed several best practices as practical strategies towards sustainability [2]. The practices are adopting green operations and maintenance practices, implementing green cleaning policies, developing alternative transportation strategies, coordinating procurement efforts, establishing recycling programs, promoting innovative landscape and maintenance, evaluating food purchasing procedures; and organizing student and staff education programs to reduce energy and water consumption.

These practices is however still not considered as a solution to sustainability issues in campus operation. For instance, a simple recycling garbage process is still not well practised at the majority of Indonesian campuses including within the IHE. Waste is still conventionally treated and sent to the garbage depot without further processing or recycling. Some attached figures on waste treatment in one of the IHE depict the conventional practice waste management [3].

The awareness on efficient energy and water consumption are not a big issue in most IHE campuses. Recent trend in the increasing of electricity consumption are due to the high demand of air conditioner for lecture theater and office usage. Another problem is the uncontrolled use of paper for administrative purposes which supposedly can be avoided by maximizing the implementation of Information Technology (IT).

Figure 1.1 shows the current situation in one of IHE, in which organic waste is mainly derived from post-consumer food from the canteen. Other waste is contributed by leaves that have fallen from trees around the campus.



Figure 1.1: Bins are not Separated for Organic and Non-organic Waste for Recycling

1.1 Research Problems

This research will address the following questions:

- a. To what extent are IHE institutions ready towards a smart green campus practices?
- b. How smart technology (IT) can support green or sustainability practices based on the current situation in IHE institutions?
- c. What type of technology that will be suitable to support the implementation of green campus practices for IHE institutions?

1.2 Research Objectives

The main objective of this research is the development of a smart green campus model towards environmental sustainability in the IHE. To achieve the main objective, specific secondary objectives will be addressed:

- a. To identify the current practices in IHE institutions with regards to sustainability.
- b. To measure the readiness of IHE institutions towards a smart green campus.
- c. To develop a smart green campus management model.
- d. To develop a prototype of smart energy saving system for public buildings.

1.3 Research Focus

This research will collect data from IHE institution to measure their readiness towards smart green campus. A proposed model of smart green campus will be developed based on empirical data from survey and observation through referenced university (Kagoshima University, Japan). Eventually, a prototype of smart energy saving system will also be developed.

1.4 Research Output

The output generated from this research will be multi-faceted, as follows:

- a. A proposed smart green campus model for IHE institutions.
- b. A prototype of smart energy saving system for public buildings.

2. LITERATURE REVIEW

In recent years, the terms ‘smart green campus’ have been popularised by universities which place environmental and sustainability issues high in their list of values. Most universities in the United States of America (US), Europe, and Japan today have sustainability programs to counter environmental issues. A number of universities in the US and UK use their website to promote and report what they have done in relation to on-campus sustainability programs. For example, Boston University ran sustainability programs which were integrated into the university’s strategic plan as early as 2005-2007. One of the interesting sustainability programs in Boston is supported by four working groups that cover recycling and waste management, energy conservation, sustainable building and facility operations, and communication and outreach [4].

There are several lessons learned from universities which have engaged in sustainability/green practices. For instance, the Oxford Brookes University with regards to reduce energy consumption has been replaced to energy efficient lamps such LEDs [5]. These energy efficient lamps are supported by lighting controls such as daylight sensors and motion sensors for further energy savings. Another lesson originates at the University of Ohio uses computer management software that shut downs the computers in their campus if they are not in use [6]. This practice helped the university to save 15,150,000 kilowatt hours and 15,000 tons of CO₂ emissions.

In the University of California at Santa Barbara has a new construction for a laboratory building which saves the university about USD 50,000 for energy cost and prevents 275 tons of CO₂ emissions per-year. Interesting to note that in some of universities in the US had launched programs to greening the transportation. For example, there are car sharing programs, 'ride your bicycle to school' program in the University of Washington [7] and using biofuels/alternative fuels for university shuttle in University of Alaska and UCLA [8].

In the United Kingdom (UK), there are several universities that have waste management units to accommodate waste on their campuses. For instance, the University of Nottingham Trent and the University of Brighton are considered to be two of the 'greenest' universities in the UK according to annual people and planet league assessment for year 2016 [9]. While, in Idaho University in the US, students has awareness on sustainability by sorted through their residence hall dumpster and divided for recycle, composted or re-used [10]. The benefit of a waste management system -- for example, producing compost as an output from post-consumer food waste -- can reduce the expense of waste management by government. Moreover, carbon emissions and energy usage can also be reduced, while also benefiting the soil by enriching it with organic matter, which is good for plant development and growth [11].

University of Copenhagen, one of the prominent university in Denmark, has launched a new ambitious target for sustainability titled "Green campus 2020: A Strategy for Resources Efficiency and Sustainability". This initiative was developed together with 9 leading universities in the IARU as a guide for the universities that wants to be responsible and address their own environmental impacts [12].

The University of Tokyo in Japan has Sustainability Initiative at U-Tokyo carrying out initiatives aimed at low-carbon practices for the University of Tokyo, which is the biggest carbon dioxide emitter in Metropolitan Tokyo [13]. TSCP has approached the goal of reducing non-experimental CO₂ emissions by 15% (from the 2006 level), and is now exploring specific measures aimed at attaining a 50% reduction in CO₂ emissions (from the 2006 level) in 2030. Since the Great East Japan Earthquake, TSCP has been implementing power-saving measures aimed at substantially reducing electricity use at summer peak-load times. These measures have proved very effective, such as by sharply reducing electricity fees. TSCP engages in other activities, such as using the above initiatives in sustainability education and conducting international exchange on campus sustainability under the International Alliance of Research Universities (IARU), in which the University of Tokyo participates.

3. EXPERIMENTAL WORK

This study was employing mix research method where both quantitative and qualitative approach were implemented.

3.1 Type of Data

Two types of data were collected for research purposes: primary and secondary data. The primary data was including a questionnaire to measure the readiness of the research object towards smart green campus initiatives, in-depth interviews with representatives of the research object, and observation. The observation was also included some activities in Kagoshima University such as visiting some areas in campus with regards to waste management, attending presentation about Eco-Project organised by university students. and interview with some academicians. Secondary data, such as campus map and university reports, was used as complementary data to support the achievement of the research objectives.

3.2 Research Design

A number of stages should be carried out in relation to the development of a smart green campus model. Those are:

1. Campus mapping and current situation in IHE institutions, including:
 - a. Provide a campus map to show research focus.
 - b. Identify type of energy use, in-campus transportation, waste.
 - c. Identify strength of research object to initiate smart green campus.
2. Identify the technology and/or method which is most suitable for implementation in line with current situation of research object.
3. Develop a smart green campus model includes governance for IHE institutions.
4. Develop a prototype of energy saving system for assisting the green practices for IHE institutions.

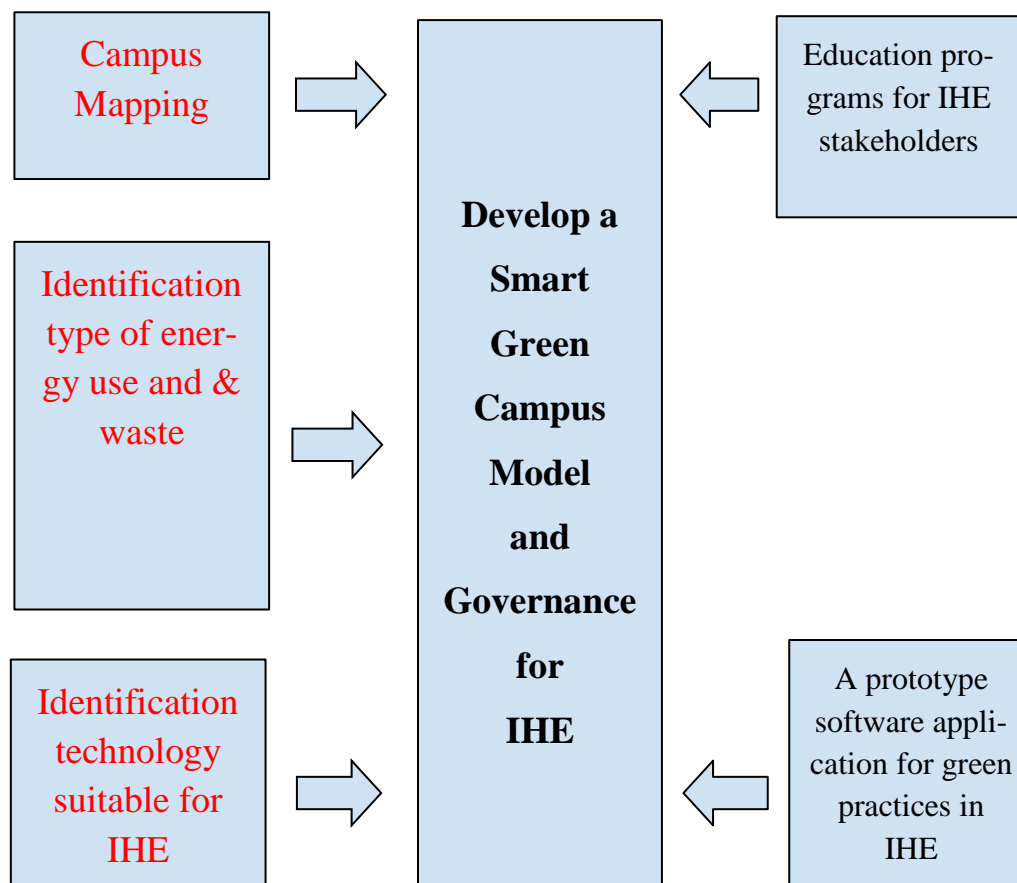


Figure 3.1: Research Framework

Figure 3.1 shows the framework of this research. It can be seen from Figure 3.1, the first stage of this research was conducted in May to August 2017 and the second stage which consisted some research activities such as developing a prototype of energy saving system for green practices in IHE institutions was implemented during September to december 2017.

3.3 Questionnaire Design

The questionnaire was designed to address the research objective, and was informed by current literature reviews on energy-saving and waste management. Several administrative issues needed to be taken into account when designing the questionnaire, for example, the questionnaire length, how easy it would be to read and understand, and the use of an accompanying cover letter to briefly explain the research objectives.

This research questionnaire consisted three parts:

- a. Part A. Demographic.
- b. Part B. Perception and Practice of Energy-Saving.
- c. Part C. Perception and Practice of Waste Management.

4. RESULT AND DISCUSSION

Research was conducted for the duration of 8 months from May to December 2017. The following sections describe the collected data.

4.1 Quantitative Result

Data collection for this research was conducted at Faculty of Science and Technology, UIN Sunan Kalijaga using a questionnaire-based survey.

4.1.1 Demographics

The respondent of this survey were lecturers, administration staffs and students. A summary of the response rate for the questionnaire distribution is shown in Table 4.1.

Table 4.1. Questionnaire Response Rate

Respondents Classification	Items Returned	Response Rate
Lecturer	34	34%
Administration Staff	30	30%
Student	36	36%

Of the 100 respondents, 56 were male and 44 were female. A histogram in Figure 4.1 shows the distribution of respondents by gender.

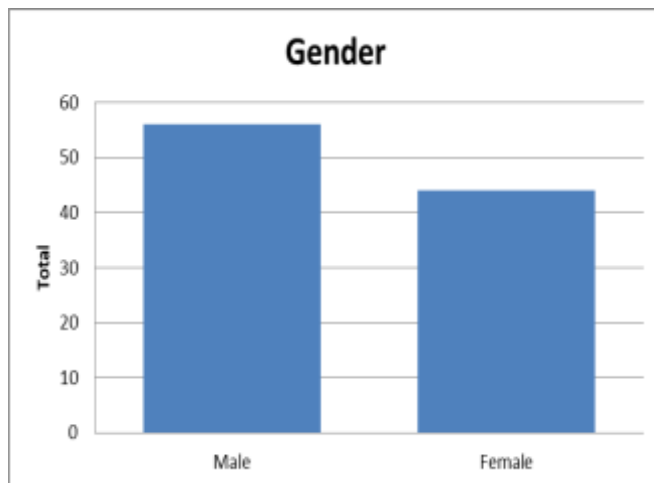


Figure 4.1: Respondent’s Gender Proportion

Figure 4.2 shows the distribution of respondents based on their educational level. It can be seen that majority of respondents were hold bachelor, masters and doctoral degree (56%) while the rest hold high school degree and diploma.

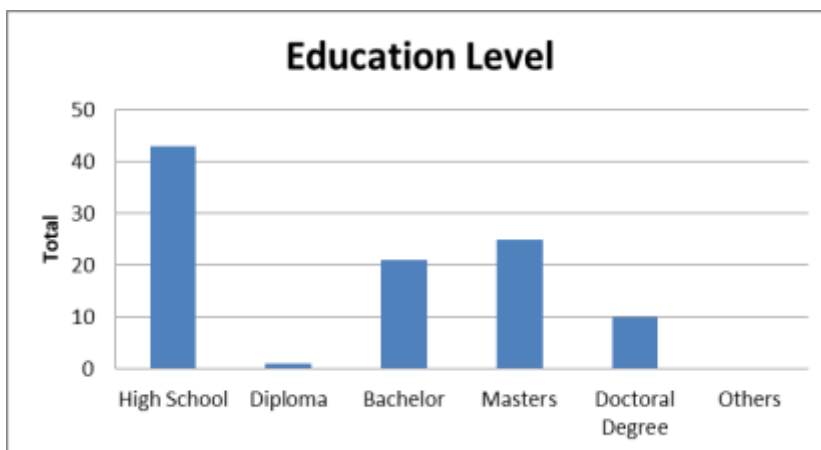


Figure 4.2: Respondent’s Education Level

4.1.2 Perception and Practice

Descriptive statistics were used in this study to find out the mean of energy-saving perception and practice as well as waste management perception and practice from respondents. Data was processed using SPSS 16.0 and results were presented in Table 4.2 and 4.3.

Table 4.2. Perception Rate on Energy Saving and Waste Management

Perception	Mean
Energy-saving	6.0600
Waste management	6.5600

In Table 3.2 we can see that mean of waste management perception was higher than energy-saving perception. From the mean value, both perception of energy saving and waste management from respondents were quite good (6 out of 7 Likert scale). While in Table 3.3, mean of waste management practice was lower than energy-saving. However, from the other side, some observation were made as evident of waste management and energy-saving practices inside the faculty. For instance, the lack of awareness from the people in the faculty to separate the waste according to its type when thrown into the provided bins. It is also proved from interviews with garbage collectors that they still have to sort out the waste again before sending to the final dump.

Table 4.3. Practice Rate on Energy Saving and Waste Management

Practice	Mean
Energy-saving	6.0800
Waste management	5.6800

4.2 Qualitative Result

Some qualitative results from interviews both with representatives of UIN Sunan Kalijaga and Kagoshima University; and also visual documentation are reported here.

4.2.1 Waste Management at Indonesian Higher Education (Sample: UIN Sunan Kalijaga Yogyakarta)

Waste placed directly into the garbage bin in every campus, for garbage outside the building such as dried leaves swept by a cleaning staff. Furthermore, garbage on a regular basis (which collected twice a day at noon and afternoon) was transferred by cleaning staffs to temporary disposal sites in each faculty or building everyday. There are some faculties or buildings that do not have temporary dumps, so garbage was placed at certain places in the building. In the following day, the waste is taken from temporary disposal sites in the university to send to the final waste disposal in Piyungan, Bantul. The charge for waste disposal is IDR 24,000/kilograms. Because of waste are not sorted out first time when it thrown to the bins, at the final waste disposal the garbage collectors have to sort them again with a help from ragpickers. Figure 4.3 shows the details of waste management inside the university.

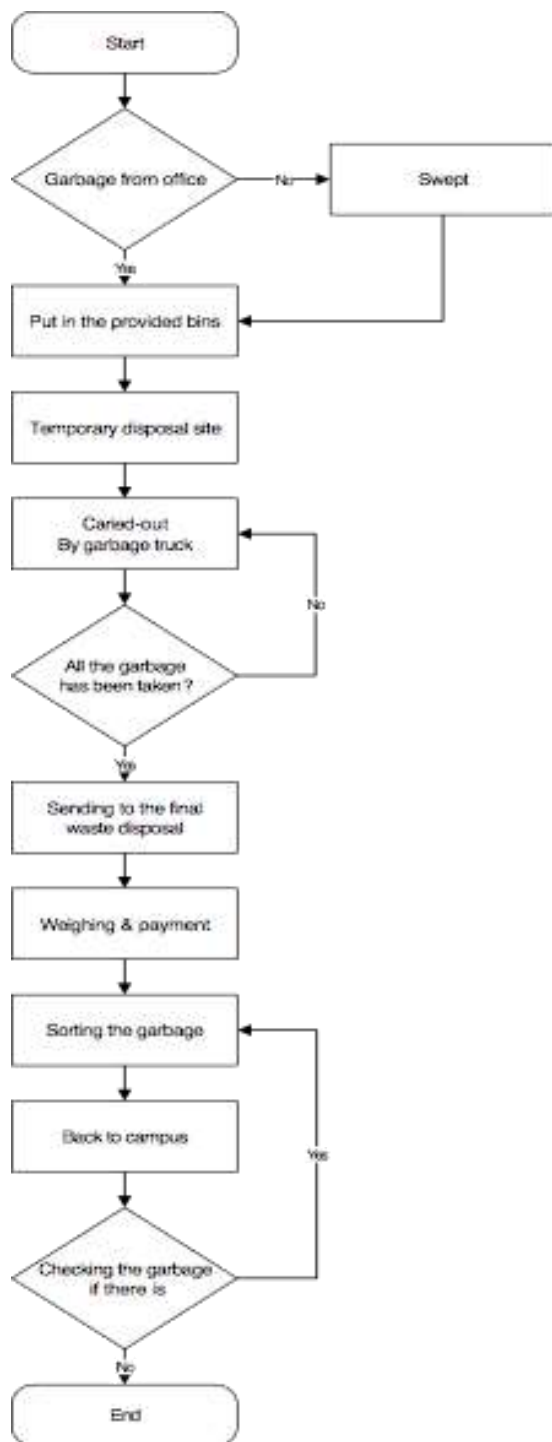


Figure 4.3: Typical Waste Management Process in Indonesian Higher Education

4.2.2 Waste Management at Japanese Higher Education (Sample: Kagoshima University)

Waste management in Kagoshima University is not only responsibility of the university but also responsibility of the local government through the gomi center. In Kagoshima City, there are two types of waste management which classifies into household and industry. Through the interview session with Associate Professor Shuichi Ishiarada from Kagoshima University, he explained that fifteen years ago there was a big problem of household garbage when they burnt. This is because of dioxide produced from burnt garbage. The other problem was arisen from industry, they likely to throw directly their waste into the sea or river and mountain because they did not want to pay to gomi center. Today, household waste which can be burnt will be collected by the garbage truck and send them to gomi center. Each houses should separate their wastes according to the city regulation. While industrial waste applies provincial regulation for their waste management.

In Kagoshima there are four types of bin i.e. burnable, non-combustible, plastic bottles and glass or tin bottles. In Japanese big cities like Tokyo, normally waste classified into seven types. In Japanese villages, the waste classification can be up to 27 types because of their gomi center is simpler than those in big cities. The household also manage to separate their wastes and put in the plastic bags

with a name on it. If the garbage collectors do not find the name on the bags, they will not collect the garbage. Japanese people are normally obey the rules in particular people in villages even though some people in big cities also disobey the rules. The budget of waste management in Japan is obtained from tax.



Figure 4.4: An Explanation on Waste Management System at Japanese Higher Education by University Representative

In university, waste from academics and staffs follow the rules as in industry while students manage wastes as in household. The waste from academics and staffs manage by a company and the university will get paid from their waste. The university normally get JPY 1 million from the waste disposed. There are strategy implemented in Kagoshima University to reduce waste i.e. paper-less, increasing ratio of recycle and Eco-project. Waste from hospital and on-campus accommodation is treated as industrial waste and laboratories uses chemicals have self-treatment of their waste.



Figure 4.5: A Prototype of Paper Waste Disposal System at Japanese Higher Education

4.2.3 Energy Efficiency Initiative at Japanese Higher Education (Sample: Kagoshima University)

In 2011 when the tsunami hit Japan, nuclear usage was stopped completely and replaced with petroleum. Because of petroleum combustion caused CO₂ pollution so that other energy alternatives such using water, wind and biomass were used. The use of solar cell is commonly implemented in Japan recent years. Solar panels can be owned by ordinary houses for their own use and can be sold to the country if excessive. In Kagoshima University have solar panels to gather sunlight and it was used to meet the internal needs of the university. With regards to energy management in the university, there are two strategy used i.e. energy-saving practice and having own solar panels.

4.2.4 Energy Efficiency Initiative at Indonesian Higher Education (Sample: UIN Sunan Kalijaga Yogyakarta)

As part of the energy-saving practices in campus, this research has main activity that is installed motion sensor for air-conditioned in several rooms in Faculty of Science and Technology. Figures 4.6 and 4.7 shows the installation of motion sensor.



Figure 4.4: Motion Sensor Sparepart for Smart Air Conditioning System



Figure 4.4: Installation of Motion Sensor for Air Conditioning System

5. CONCLUSION

The research had the main objective to develop a smart green campus management model towards environmental sustainability in the IHE institutions. To achieve the main objective, specific secondary objectives were addressed:

- a. To identify the current practices in IHE with regards to sustainability.
- b. To measure the readiness of IHE towards a smart green campus.

In order to gain information from people in university, a questionnaire survey was designed and employed to collect data in Faculty of Science and Technology, UIN Sunan Kalijaga Yogyakarta. The questionnaire items were developed mainly from literatures on en-

ergy-saving and waste management theory. Several interviews were also conducted with university representatives both in Yogyakarta and Kagoshima to gain additional information.

The quantitative responses have come from 100 respondents, the majority were being from students. Even though the research had a small sample size, the sample size was statistically sufficient to represent population of UIN Sunan Kalijaga Yogyakarta. The main result of the questionnaire survey shows that respondents are good in energy-saving and waste management perceptions. However, the observation made during the data collection has shown that the real practice of energy saving and waste management in the campus were still poor. For instance, the awareness to turn-off the electricity used after office-hour were very low.

Based on the quantitative and qualitative results, an installation of motion sensor to manage air-conditioned usage of particular rooms in a university building was implemented. Based on the experiment, the application of motion sensor for air-conditioner management system was helpful in managing the building energy usage.

4.1 Limitation

All research has limitations and this research is no exception. This section outlines the limitations of the research and the opportunities for further research in this area. Those limitations are:

1. Sample
Caution should be exercised in generalising the results of the research to a wider population of UIN Sunan Kalijaga. The sample was taken from only a faculty within the university. The views expressed in the survey questionnaire were then only from people in the particular faculty.
2. Interview
The number of conducted interviews were limited by the availability of time and various difficulties in finding appropriate respondents.

4.2. Recommendations for Future Research

In order to improve the insight on smart green public spaces models especially for IHE institutions we recommend:

1. More information should be collected from university top management to better establish the smart green campus model for IHE institutions.
2. Research should be extended to obtain the views of wider respondents in other faculties and IHE institutions.

ACKNOWLEDGMENT

This research was conducted using international collaboration research grant courtesy of UIN Sunan Kalijaga Yogyakarta.

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