Towards Zero-Waste Campus: Perception of the Community in UTHM Pagoh Campus on Solid Waste Management System

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Abstract. The solid waste crisis has become one of the contributors to environmental issues such as climate change, environmental pollution and loss of rainforest. The contribution of Higher Educational Institutions (HEIs) in achieving sustainable development and society is undeniable. With the ethical and moral obligations to act responsibly towards the environment, they tend to become leaders in the movement for environmental protection. As a new branch of the Universiti Tun Hussein Onn (UTHM) campus, the UTHM Pagoh Campus aims to become one of the green campuses at Pagoh Educational Hub. A well-managed Solid Waste Management (SWM) can provide a number of benefits, such as reduction in waste disposal cost as well as creating awareness among the campus community. In this study, interviews were carried out with the stakeholders to obtain in-depth information regarding SWM on campus. From the interviews, it was found that the main challenges faced in implementing SWM on campus are: low awareness among the community; lack of policy and guidelines on SWM; and insufficient facilities. To overcome these challenges, the “Zero Waste Campus” (ZWC) initiative is proposed to be implemented on campus in order to reduce the waste stream. The ZWC covers several aspects of the campus’s SWM, such as policy development and facility improvement.

1. Introduction
The contribution of Higher Educational Institutions (HEIs) in achieving sustainable development and society is undeniable. Empirical findings from studies on SWM in HEIs in Malaysia and other countries show that educational and policy approaches in HEIs are more effective than any other methods applied in the public [1,2]. This is because HEIs are microcosms of societies made of large populations and diverse activities taking place on campuses such as learning, research, community service and business development [3,4]. In Malaysia, HEIs have extremely important roles in supporting tertiary education [5]. With ethical and moral obligations to act responsibly towards the environment, they tend to become leaders in the movement for environmental protection.

In Malaysia, only limited studies on waste characterization have been conducted in HEIs [6]. Most waste characterization studies in Malaysian HEIs only cover certain functional buildings, such as academic buildings [7] and cafeterias [8]. It is important to have a complete waste profiling database for
the entire campus as it provides clearer insight on the waste stream from the source of waste generation to the final disposal in an educational institution. A campus which has a well-managed SWM can provide a number of benefits, such as reduction in waste disposal cost, environmental protection, as well as improvement on the health, cleanliness and safety of the community on campus. Also, the quality of SWM in a campus reflects the quality of educational services and responsibility in environmental issues [6]. Moreover, a sustainable initiative in a university can efficiently influence society and households [9]. Therefore, the main objective of this paper is to recommend appropriate initiatives to reduce solid waste generation at the Pagoh Campus of UTHM.

1.1. Background of the campus.
In September 2017, the UTHM Pagoh Campus was developed in Pagoh Educational Hub (PEH) and it was strategically located off the Pagoh Interchange on the North-South Expressway (Exit 238), about 20 minutes from the royal town of Muar, Johor. PEH was housed by 4 local HEIs in Malaysia, namely the International Islamic University Malaysia (IIUM), Universiti Teknologi Malaysia (UTM) Research Centre, Politeknik Tun Syed Nasir Syed Ismail (PTSN) and UTHM. Besides, PEH is also equipped with centralized shared facilities and a water district cooling system in all buildings.

Based on the data obtained from the UTHM administrative office, there are three (3) operating faculties at the UTHM Pagoh campus, namely Faculty of Engineering Technology (FTK), Faculty of Applied Science and Technology (FAST) and Centre for Diploma Studies (CeDS). No studies have been conducted on the waste management system on this campus so far as it is still new. As one of the campus's objectives is to move towards a green campus, it is therefore important to conduct a study to determine solid waste generation and its composition within all key campus operational areas to identify the best strategy for waste management.

On average, the waste generation rate for a regular lecture week in UTHM Pagoh campus is 203.90 kg/day, where 79.0% of the waste is generated by the cafeteria. Overall, food waste constituted 66.9% of the total solid waste on campus, followed by 19% of residual waste. The third abundant solid waste produced on campus was plastic waste, which constituted 7.1% of the total waste, followed by paper waste (4.3%). Other waste components have relatively low compositions, such as TetraPak® (0.7%), metal (0.7%), aluminum (0.5%), non-organic matter (0.6%), other organic matter (0.2%) and glass (0.1%) [10].

2. Literature Review
Over the years, many universities have started to express their concern about the solid waste crisis globally. Therefore, waste characterization studies have been conducted in HEIs in order to propose and implement adequate SWM on campus.

2.1. Efforts of HEIs towards sustainable SWM
It is not an easy task to set up environmental initiatives in HEIs. In order to implement any environmental projects successfully in HEIs, several key components should be included as follows [11]:

i. Understanding the workflow of HEIs
ii. Sufficient funding
iii. A university-wide coordination
iv. Adequate and well-planned infrastructure
v. Reliable contractors
vi. Clear and manageable policies and frameworks
vii. Awareness and knowledge among the campus community
viii. Commitment and demonstrated support for environmental strategies

Among them, policy or framework formation is evidently proven as the most effective initiative to be implemented towards sustainable waste management in HEIs. In addition, the participation of university stakeholders and integrated strategies are certainly important to ensure the best SWM performance [3,12].
2.2. Strategies adopted by HEIs in Malaysia

HEIs in Malaysia are no exception in the global movement towards sustainable development. Many research studies had been conducted on the effectiveness of SWM strategies, as well as innovative solutions in SWM on campus. Table 1 summarizes the initiatives that have been adopted or implemented on campus across HEIs in Malaysia.

| Year | Name of Institution | Initiatives | Descriptions | Source |
|------|---------------------|-------------|--------------|--------|
| 2013 | Universiti Sains Malaysia (USM) | Mini Biogas Energy plant (MBEP) | USM has launched a MBEP capable of generating 600 kilowatts of electricity a day with 1000kg of organic waste. In this plant, organic waste such as food waste and cow dung undergoes anaerobic digestion and produce methane gas (biogas) that can generate heat and electricity. | [13] |
| 2015 | Universiti Putra Malaysia (UPM) | Asia’s Best Green Campus by Universitas Indonesia (UI) - Greenmetric Ranking of World Universities | UPM has made significant improvements, particularly in the sectors of transport and infrastructure such as the size of available green space, in addition to the use of efficient energy-saving facilities and bicycles within the campus area. | [14] |
| 2017 | Universiti Malaya (UM) | Zero Waste Campaign (ZWC) | UMZWC had diverted approximately 700 tons of waste to landfills with its recycling and on-site treatment in UM since 2011. UM also set up a pilot-scale food waste digester which is able to process food waste into liquid fertilizer and biogas at a capacity of 100kg/day. | [15] |
| 2016 | Universiti Teknologi Malaysia (UTM) | Green Office practice | The Green Office practices designed to minimize dry waste and provide situational and systemic changes for behavior, such as Sustainable Meeting, Saving Paper, and Practicing Recycling, resulted in campus paper-reduction rate of 30% (2011), 42% (2012) and 58% (2013). | [7] |
| 2010 | Universiti Kebangsaan Malaysia (UKM) | Zero Waste Campus initiative | UKM collaborated with Alam Flora Sdn Bhd research group which deployed recycling activities effectively since 2010. The activities, such as the Integrated Paper Recycling Management System, 2-bin Recycling System and Mobile Recycling Centre (truck) were targeted to achieve a recycling rate of 20% on campus. | [16] |

As shown in Table 1, from the SWM initiatives implemented in different institutions, most of them successfully reduced the amount of solid waste, especially the Zero Waste campaign. The Zero Waste Campaign in UM (UMZWC) had successfully diverted approximately 700 tons of different wastes to landfills with its on-site treatment facilities [17]. Besides, the Zero Waste Campus initiative in UKM targeted to achieve a recycling rate of 20 % on campus by implementing mobile recycling trucks and a 2-bin recycling system [16]. The Green Office initiatives of saving paper implemented in UTM also reduced the volume of paper used on campus from 58% to 30% [7].

With proper waste separation and recycling practices, the waste stream in a HEI campus would be significantly reduced [16]. Nevertheless, unlike universities abroad, the SWM policy implementation in HEIs is not common in Malaysia due to a lack of resources, which is also the main challenge faced at the national level [18].
3. Methodology/Materials
In this study, the qualitative method was used to gather data pertaining to SWM implementation at UTHM Pagoh campus. As an educational institution, UTHM Pagoh Campus has its own organization and management system on SWM implementation which is different from other institutions. Thus, interviews are used to gather in-depth information about the implementation of SWM at the campus. The data is ultimately important to develop a tailored set of recommendations for improving SWM on campus. As mentioned earlier, UTHM Pagoh campus is a new campus and thus, there was no recorded data on the waste profile. For the record, this interview sessions were the second phase of data collection that was carried out after the waste characterization phase. From the quantitative data collection, the results for waste generation and waste composition of UTHM Pagoh campus were obtained. However, the waste profiling only captured the types and amount of waste produced on the campus, but not encompassed the details of SWM on the campus such as the process of SWM, the facilities available for SWM and the challenges occurred in implementing the SWM system on the campus. In this case, the stakeholders of the campus were selected as target respondents for the interviews seeing that they are more familiar with the planning and implementation of SWM strategies (refer to Table 2).

Table 2. Roles of respondents and the corresponding company

| Roles in SWM                        | Corresponding company                      | Number of respondents |
|-------------------------------------|--------------------------------------------|-----------------------|
| Facility management in UTHM Pagoh Campus | Universiti Tun Hussein Onn Malaysia (UTHM) | 2                     |
| Main contractor                     | Sime Darby Property Selatan Sdn. Bhd. (SDPS) | 2                     |
| Janitorial contractor               | Takwa Service and Enterprise               | 2                     |

A set of interview questions was the main instrument used for data collection. One of the goals of the interviews is to obtain comprehensive information about how solid waste is managed and implemented over time in UTHM. Therefore, the interview questions were designed to obtain their views and opinions on existing policies and strategies on SWM on campus. The interview questions included the following aspects:
- Current SWM practices on campus
- Challenges to practice proper SWM on campus
- Recommendations to improve SWM on campus

The duration of each interview session was approximately 30 minutes. During the interview, a recording device was used and important notes were taken by the interviewer. The recording was transcribed and analyzed afterwards. It is important to note that the interviews were carried out in Bahasa Malaysia. The responses extracted from the transcription were then translated into English. The interview transcripts were analyzed by manual coding and categorized into major conceptual areas, such as the current practice, strategies, management, challenges and recommendations.

4. Results and Findings
4.1. Overview of SWM in UTHM Pagoh Campus
From the interviews with the janitorial and the main contractors, it was found that SWM in UTHM Pagoh Campus only covered the basic process of waste handling, i.e. cleaning, storage, and collection of solid waste. The waste in the RORO bin was then collected by the appointed waste disposal company once or twice a week depending on the amount of solid waste generated. The process of SWM from waste generation to the final collection at UTHM Pagoh Campus was identified and illustrated in Figure 1.
According to the facility management of the campus community, dustbins were provided for every structure on campus to prevent littering on the ground. In addition, there were 10 spots on campus equipped with recycling bins. Unfortunately, the recycling bins were not wisely used as all rubbish was disposed of without separation. Besides, it was also found that the janitorial staff did not store recyclable waste separately. Instead, they mixed recyclable waste with general waste and disposed them at the final collection point. This situation shows that the awareness of the community on separating waste at the source is still very low.

4.2. Challenges faced in carrying out SWM on campus

From the interviews with the SWM stakeholders, a few challenges on conducting sustainable SWM practices at UTHM Pagoh Campus were identified and summarized as follows:

i. Low awareness among the community

ii. Lack of policy and guidelines on SWM

iii. Insufficient facilities

In this study, it was found that awareness of the community was the biggest challenge to achieve sustainable SWM on campus. From the interviews with the SWM stakeholders, it was found that the campus community was unable to associate environmental impacts with poor solid waste management. In other words, they do not have a clear idea of the methods as well as the reasons to separate waste. Next, according to the respondents, laziness among the campus community might have led to a high composition of the residual waste on campus. For example, all the food vendors in the cafeteria zone only provide single-use plastic cutlery instead of reusable stainless steel cutlery. When asked, the vendors claimed that they preferred single-use plastic to stainless steel cutlery because they find it a hassle to wash the cutlery every now and then. Moreover, they find it a waste to purchase a large quantity of cutlery and having to risk them being accidently thrown away by consumers or mistakenly taken away by other food vendors. In addition, for the sake of convenience, students and staff prefer takeaways. They can simply throw away the plastic containers and bags after finishing their food or beverage. If they bring their own lunch boxes or bottles, they would have to remember to bring along their containers to the cafeteria and wash them after use. The campus community finds this a nuisance as they are not ready to change their lifestyle to help conserve the environment. This finding is supported by [19] who stated that even though the public professed the “correct” attitude towards the environment, many are still not ready to change their lifestyle in ways that might require sacrificing certain forms of leisure and comfort for the sake of the environment.

The second challenge mentioned from the interviews with the stakeholders is the attitude of the campus’s community towards SWM on campus. As a consequence, the community does not have any liability for improper waste management practices. In addition, the campus’s authority does not have a well-planned framework for SWM, including the responsibilities of stakeholders, waste minimization and a systematic waste collection system. The UTHM Pagoh Campus also does not have a unit or department with professional or experienced personnel to govern the implementation of SWM policy on campus.

From the interviews with the facility management staff, the facilities for SWM on campus are insufficient. For instance, within the entire academic building, only 1 set of recycling bins was available.
at Level 2 of the building. This is an inconvenience for the users from other levels in the academic zone. On the contrary, there are too many bins for general waste on campus compared to recycling bins. This situation probably caused the failure of waste separation at source as the community tends to throw all their rubbish into the general waste bins. The community usually chooses to use the facility which is more convenient and reachable. Besides, no notice or information such as “what can be recycled?” or “how to separate waste at source?” was observed in the campus compound. From the interviews with the contractors, it was reported that informative facilities should be introduced around the campus to educate and encourage waste reduction and recycling habits.

4.3. The “Zero Waste Campaign” (ZWC) initiative

From the results obtained from the interview sessions, it is recommended to implement the Waste Campaign” (ZWC) at UTHM Pagoh campus. Taking into account the results for waste generation, waste composition and the challenges faced in relation to SWM on campus, the ZWC should be implemented through the following aspects:

4.3.1. Policy design and implementation. It has been proven by many researchers that policy is one of the most effective tools for waste reduction initiatives [12,20]. In order to minimize the solid waste generated on campus, a set of written policies should be developed and enforced by the campus authority. In addition, it can serve as a term of reference for each stakeholder.

Mandatory waste separation at source is one of the essential elements which should be considered in the policy. Introduction of this policy would obligate the community to separate their waste into basic categories such as food waste, residual waste and dry waste. Warnings and punishments should be enforced to those who fail to segregate their waste appropriately. These policies should be highlighted and displayed at visible spots around the campus as a reminder to the community. In addition, the introduction of the policies should be emphasized during every orientation session for newly registered students and staff. Mandatory waste separation at source will not only prevent recyclable waste from being disposed of in landfills, but also helps to reduce the cost of waste transportation and disposal.

In addition to reducing the waste generated by consumers, the policy will be able to reduce waste generated by vendors as well. Banning the use of single-use products would greatly reduce the amount of solid waste generated. Single-use products such as plastic straws, plastic bags, polystyrene utensils and paper cups are typically not recyclable. Therefore, when the usage of single-use products is prohibited, both vendors and consumers will be required to use reusable or biodegradable products.

In order to cut down the carbon footprint on campus, paper-reduction or paper-saving initiatives should be implemented, especially in the academic zone. Paper is a material that is fully recyclable and should be diverted from going to landfills. As paper is the second largest waste component in the academic zone, the “Paperless Policy” should be implemented specifically to academic staff, administrative staff and students. For example, the Green Office policy implemented in UTM managed to reduce 20 % of the paper consumption rate within a one year period. As a result, the cost of paper usage was significantly reduced, as well as the carbon footprint [7]. As an alternative to the implementation of the “Paperless Policy” on campus, paper usage could be replaced by electronic materials such as electronic notes, online tests, online assignments and online forms.

Another option to be included in the SWM policy is on trainings and campaigns. This is because these options have been proven as effective tools in shaping the characteristics of the society [21]. For any 3R campaigns to succeed, it is important to attract publicity among the campus community. The promotion of 3R awareness can be done by placing posters and infographic materials at visible spots around the campus such as dining tables, elevators or bulletin boards. Besides, expertise from recycling centers or waste management companies can be invited to demonstrate proper ways to practice recycling on campus.

4.3.2. Facility improvement. Insufficient facility is one of the challenges that caused the failure of waste segregation by the campus community. The facilities for waste segregation on campus need to be
designed according to the functions of buildings and capabilities. After reviewing the opinions of the stakeholders, several recommendations were provided on facility improvement after taking into consideration the waste generation and composition results in each campus zone.

As food waste was found to be the most abundant solid waste, it is highly recommended that a composting machine be placed on campus. The ZWC in UM had diverted food waste disposal to landfills and the campaign had earned extra income from the compost products sold [15]. There are several composting machines in the market which are capable of processing food waste generated on campus. These composting machines are able to turn food waste into organic compost within 24 hours. By having a composting machine, the amount of waste sent to landfills and Green House Gases (GHGs) emission would be reduced significantly. On top of that, the end products from the composting machine can be sold to agricultural industries nearby as fertilizers or animal feed.

Furthermore, user-friendly waste separation facilities should be placed appropriately throughout the campus to encourage the recycling habit among the campus community. Apart from the recycling bin, a facility for buyback services or deposit programs may encourage the community to recycle their waste as they will be rewarded whenever they practice recycling [22]. For example, the Reverse Vending Machine (RVM) is a concept in which the user will get rewards when they recycle items such as aluminum cans and PET bottles accordingly. Based on research done by [23], approximately 26% more PET bottles were recycled after the implementation of RVM at King Mongkut’s Institute of Technology Ladkrabang (KMITL) in Thailand.

5. Conclusions
In conclusion, the biggest challenge at UTHM Pagoh campus in terms of practicing sustainable SWM is the low awareness among the campus community. Besides, there is no specific guidelines and policy for the SWM on campus. Other challenges that lead to improper SWM practices include the lack of specialists in SWM and insufficient facilities for waste segregation. A “Zero Waste Campaign” (ZWC) is an initiative that incorporates campus recycling and waste reduction programs within a campus. This covers multiple aspects including policy development, facility improvement, 3R campaigns, environmental awareness and education. As an educational institution, the community should be educated and molded to become more environmentally conscious. The importance of reducing the solid waste in our community should be conveyed to students as well as the staff so that they will be encouraged to practice waste minimization. It is proposed that the stakeholders of UTHM Pagoh campus should consider developing workable guidelines and initiatives that would reduce the generation of solid waste on campus. Furthermore, the university can extend its community services on SWM through collaborations with third parties and by establishing a technology transfer center. Above all, a successful ZWC concept will be able to show the commitment of HEIs in protecting the environment and becoming a role model for other sectors.

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