

Waste-to-Wealth: Bio-Recycling Centre as Living Laboratory Element to Create Integrated Bio-Waste Management for Institution

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Abstract

Waste-to-wealth has been used as the concept to address the environmental problem by changing the traditional view of waste as an end product to be disposed off. Raising awareness on environmental issue and turn it into potential value has seen as a big challenge to the university, as most system relies on operational behavior. Typically, the bio-waste management in campus facing with issues of poor waste management by contractor, unsystematic disposal management, the ineffective mechanism of waste segregation which eventually lead to the involvement of high and burdensome operational cost. This short communication reports the current bio-recycling initiatives implemented in the Universiti Teknologi Malaysia (UTM) and provides some viewpoint in the conclusion to improve the current bio-recycling implementation with an objective to address problems that have been aforementioned and highlights its market potential for institutional income.

Keywords: Waste-to-wealth; Sustainability; Bio-recycling; Living laboratory; Bio-waste

Introduction

Supporting the financial of university was never an easy task, as it requires lots of additional potential income generation to fund the specific institutional operation. Financial sustainability issues have significantly give impact to most universities in Malaysia [1]. According to Kasim [2], up to date, only five out of 20 public universities are known as Research University (RU) which mean they are able to receive additional funding for Research, Development and Commercialization (R&D&C). Realizing that there is big potential of integrating the research with commercialization, UTM as an agent of transformation has set a framework of waste-to-wealth concept throughout the Bio-Recycling Centre as one of core element in the Living Laboratory. This idea is not only generating the profit for the university, but also help in disseminating awareness among the campus citizen, especially on sustainable and environmental issues.

Previous study showed that, although there is continued improvement in awareness of sustainable waste management strategies, in term of operation level, the production of large amount of waste in UK universities shown the requirement of improvement alongside the best recycling practices [3]. One of the universities that

become the best model of increasing focus on sustainable development in operation level in UK was University of Leeds [4]. University of Leeds (UoL) in UK as the best example has been focused on the improving the sustainable development at the operational level through improving the waste management efficiency in the past few decades and it significantly showing a tremendous impact in increment of recycling rate and reduction in its waste to landfill [4].

The drastic implementation of public spending cuts have led UoL in finding a way to save costs and at the same time reducing the carbon emission through their high impact different approach in sustainability program which have received awards, such as the highest grade in People & Planet Green League and Silver in the Business in the Community Environmental Index [5]. As a result, these programmes have enabled them to get a huge savings of hundreds of thousand of pounds and is expected to further down the cost and at the same time helping to reduce the Green House Gases (GHG) emission (UoL 2011a). The calculation of 100% source segregation of food waste in UoL is as shown in Figure 1. Through this calculation, it enabled UoL to save more than £ 500 a month, or more than £ 6,000 per year just for food waste alone. This is equivalent to MYR 2,818 for a month and MYR 33,810 per year. Apart from the significant cost reduction, it is also could help reduces the contamination of waste streams and increases its usability and value.

	Jan-11	Cost in £	Feb-11	Cost in £	Mar-11	Cost in £	Apr-11	Cost in £	May-11	Cost in £
MRF: Kitchen & canteen waste*	18.3	1,370.49	17.52	1,312.07	20.23	1,515.02	12.49	935.38	18.58	1,391.46
Food Waste (dedicated)*	1.18	52.58	3.48	155.07	3.81	169.77	4.44	197.85	3.40	151.50
Potential saving in £ per month*		555.04		531.38		613.58		378.82		563.53
*excl. VAT and transport costs										

Figure 1: Potential monthly saving through efficient food waste segregation [4].

From the comparison with UoL, the efforts towards creating an integrated bio-waste management in UTM is seen as crucially needed in order to improve the waste management, minimize the waste generation and to cut the cost for waste management, and unlocking the potential resource of profit in UTM and significantly disseminate environmental awareness and entrepreneurship in the campus. Thus, this paper described the initiatives done by UTM to address the problem of poor waste management and this eventually making it as a source of income to the university without affecting the environment.

Bio-recycling center as core element in living laboratory

Bio-recycling Centre is created to integrate the collection of wastes from various sources, such as food waste, green waste and solid waste, in order to promote the healthy lifestyle and further practicing the entrepreneurial spirit among university's citizen. Through some researches and sustainable practices, the implementation of Sustainable Arcade (Green Cafeteria) and Bio-Recycling Centre in UTM shows some improvement in the waste management since it was implemented on 2010. Through the UTM Campus Sustainability flagship project, a total of 9 researchers have conducted a 7 months research on project title "On-Campus Bio-Recycling Of Food and Green Waste Into Compost" in order to produce a feasibility report on scaling up the bio-composting process and also to scale up the current practice in amount of food waste collection (80 kg/day to 400 kg/day). This ongoing research has become a gateway for UTM functionality as a Living Laboratory towards Zero Waste Society and creating a small scale composting of food and green waste. The quantity of food waste (kg) collected since September 2014 to March 2015 has been recorded and presented in Figure 2. However, this data only represent for 2 sustainable arcades at that time, namely Meranti and Cengal.



Figure 2: Quantity of food waste collected since September 2014 to March 2015.

Through the data from the collected food waste in September 2014 until March 2015, the total of quantity of food waste collected for that 7 months study is 14,303.70 kg or 14.30 t, which mean about 2.04 t/month. Therefore, the roughly amount of food waste in tonnes per year is about 24.52 t/year. Out of the amount of average food waste dispose to the landfill, only 2% will be separated for purpose of bio-product processing with 60% of it will be used to produce the bio-compost fertilizer, while 40% will be focused on the production of feedstock. Currently, there is 4 arcades namely Meranti, Chengal, PHB and Kolej 9 engaged in the production of bio-compost fertilizer and feedstock.

The solid waste around the UTM campus was collected under the responsibility contractor, Tahang Sdn. Bhd. up until now. At present, the 2% separation of food waste for bio-compost product did not happen at rest of 114 cafeterias in this campus. Problem such as the difficulty in finding the previous data especially on how much food waste generate from the solid waste for the rest cafeteria in UTM campus is one of the constraints during preparing this paper.

Thus, our aim is not only to share the current implementation of our small scale bio-recycling center, but also to provide and show the overview of potentially saving in transportation cost for food waste disposal to landfill and the total sale able amount or profit per year from production of bio-compost fertilizer and feedstock which can help generate income to campus. The potentially transportation saving for waste disposal to landfill, estimated sale able amount in MYR per year for bio-compost product is presented as in Table 1.

Year	2010	2011	2012	2013	2014
Total solid waste (tonnes)*	3425.6 8	3520.4 2	3368.9 1	2289.6 4	2758.0 5
Total cost in MYR per year **	411,08 1.60	422,45 0.40	404,26 9.20	274,75 6.80	330,96 6.00
Average food waste per year (in tonnes) to landfill ***	1678.5 8	1725.0 1	1650.7 7	1121.9 2	1351.4 4
Potentially collect able amount for bio product from food waste ****	33.57	34.50	33.02	22.44	27.03
Potentially transportation saving in MYR for waste disposal to landfill *****	4,028.4 0	4,140.0 0	3,962.4	2,692.8 0	3,243.6
Animal feed (60%) in tonnes per year	20.14	20.70	19.81	13.46	16.22
Estimated sale able amount in MYR for feedstock per year	6,042	6,210	5,943	4,038	4,866

Fertilizer (40%) in tonnes per year	13.43	13.80	13.21	8.98	10.81
Estimated sale able amount in MYR for fertilizer per year	6,715	6,900	6,605	4,490	5,405

Table 1: Potentially transportation saving for waste disposal to landfill and estimated sale able amount from bio-compost product. (Source: Unpublished data from Office of Assets and Development (UTM)).

Note: *Data obtained from Office of Assets and Development (OAD)

**Total solid waste x MYR 120/t

***49% from Total Solid Waste

****2% form Average food waste per year (in tonnes) to landfill (the 2% is obtained from the percentages of total tonnes of food waste produced just for bio-compost product which is 24.52 tonnes/year divided by Average food waste per year (in tonnes) to landfill ≈ 2%

*****Potentially collect able amount for bio product from food waste x MYR120/t

The data tabulated in the Table 1 shows the potentially transportation saving for waste disposal to landfill from the 2% separation of food waste from the average food waste per year for bio-compost product and the estimated sale able amount in MYR for fertilizer and for feedstock per year. This can significantly help the institutional to reduce the burden of transportation cost for food waste disposal to landfill and also gives an overview of profits from the 2% conversion of food waste to bio-compost value added product. The changes of 2% to 100% of food waste conversion to bio-product will contribute to the big saving in transportation cost and also give a high impact of gross margin profit if it is carried out in campus.

Potential of food waste: bio-compost fertilizer and animal feedstock

The increment of waste management expenses for operational management has become a major factor that inhibits the solid waste management in general [6]. Failure in disseminating and integrating the best practices among the campus citizen and operational of cafeteria waste have significantly contributed to the increment of operating cost. The situation worsened as there is no awareness for sustainable entrepreneurship mechanisms to optimize the operation costs and awareness campaign. Therefore, UTM has utilize the Bio-Recycling Centre to develop the potential of income generating from campus food waste, including the marketing of the end products. This initiative aims for two types of end product with a high commercial potential, namely; 1) Bio-Compost Fertilizer and 2) animal feed production. These products usually purchased from external parties for campus's internal usage (e.g. landscape, plantation and animal feeds). Since 2010, these products purchased were reduced significantly from 5–10%, which clearly minimize the expenditure bills for UTM. Roughly, about 100 kg/day feedstock produced from food waste (data obtained from 4 cafeterias, out of 114), and the number is increasing through populations. From total feedstock produced, the percentage of 15 till 20% of the food waste from cook and non-cook is targeted for fertilizer, while 55 until 27% for livestock.

Bio-compost fertilizer

Composting is an aerobic process that involved the biologically decomposition of the organic material which eventually produced carbon dioxide, water and heat. It is widely used as soil conditioners and soil fertilizers. The application of bio-compost as soil conditioner will increase the rate of plant growth during the photosynthesis and reproductive phase [7]. Significantly, it will also increases the hormones for plant growth and nutrient absorption, thus providing resilience ability towards drought and moisture stress [8]. Basically, the production of bio-compost fertilizer will involve the food waste collected from food arcades around the campus and further process is to mix up with shredded garden waste. Effective Microbes (EM) that has been produced by university's researcher was used as natural accelerator for decomposition processes.

The step-by-step involved in this process can be simplified as shows in Figure 3.

Animal feedstock

Meanwhile, for animal feedstock, the collected food waste will undergo several steps before ready to be used as feedstock and for commercial packaging. The collected food waste will be manually segregated to separate the solid waste and food waste, the leachate collection, before its' nutrition enriched with the mixture of coconut pulp and wheat flour (for livestock growth rate), and allowed to dry before it can be applied for the livestock such as chickens, lambs and ducks at UTM farm. These products have been tested to livestock at the UTM farm and the result showed the higher nutrition content in the feedstock indicated a positive development towards the growth of livestock compared to the normal feedstock purchased from the external parties. The process involved as illustrated in Figure 4.

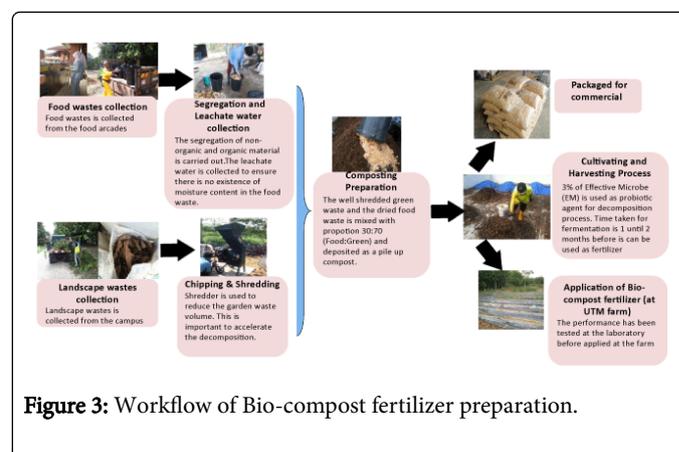
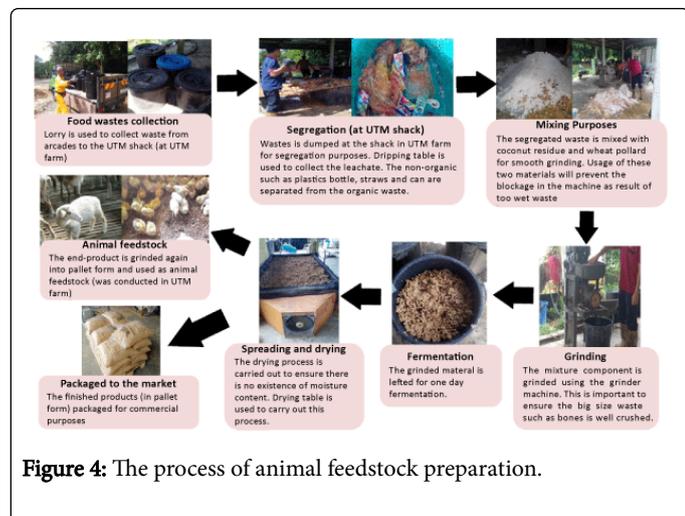


Figure 3: Workflow of Bio-compost fertilizer preparation.

To strengthen the implementation in the campus, policy makers, top management and related stakeholders need to develop a proper mechanism by considering the long term planning through integration of research element, teaching and operational for purpose of creating zero waste campus and develop sustainable entrepreneurship skills. The master plan or university's blue print need to look over the Standard Of Operation (SOP) of food arcades, contractors and Bio-Recycling Centre so it can help to achieve the mission of university towards generating income and creating Zero Waste Campus. As conclusion, this initiative is crucial as it was not only potentially reducing the dependency on outside product which significantly will affect the UTM operational cost, but will obviously could provide a

simulative, entrepreneurial and quality learning environment and concurrently provide the Happy, Healthy and Sustainable Campus [9] (Figure 4).



Conclusion

The Bio-Recycling Centre is still in the process of implementation and it cope with some issues that constrain the effectiveness of its' implementation in the campus. Lack of skilled manpower to manage bio-recycling site, problems in data collection for solid waste management in campus, lack of fund and unavailability of financial resources to support the creation of center and long term issues such as lifestyle and attitude of the campus community to give their commitment to the success of this initiative are the main issues that need to be studied and considered as factors of the success or failure of its implementation.

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