INTEGRATED SOLID WASTE MANAGEMENT AS A TOOL FOR EFFECTIVE SUSTAINABLE PRACTICE

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Abstract: The purpose of this study is to deal with the minimization of solid waste collection system in Universiti Teknologi Malaysia (UTM). The university has an approximately 35,000 staff and students, with increase in students population and infrastructural expansion hence, makes the management of UTM solid waste become a critical environmental issue in order to carter for this services. **Design/methodology/approach** - This paper evaluates the state of generation, source separation, collection, transfer/transport, disposal, characteristics, and management of the solid waste within the university environment. However, the paper x-rays the significances of effective cost reduction to the university using the integrated method of solid waste management, globally the per capital solid waste generation for every individual per day is between 0.5 to 0.8kg, and the university generation per day is between 15 – 16 tone thus given a chance for private waste collectors to be involved in managing the solid waste that is being generated in the university. **Findings** This paper proposes a new institutional and legislation framework for the proper management of solid waste and it also designed an integrated and cost effective management system, with priority to the environmental and public health protection. Meanwhile 3R system; Reduce, Re-use and Recycle were used in this study for the solid waste management hierarchy with emphasis on source reduction, intermediate treatment and final disposal. **Practical implications** this will help UTM tackle the problems cost effectiveness and environmental impacts related to solid waste management through the application of integrated solid waste management within the campus.

Keywords: Integrated Solid waste management, Practice, Sustainable, and Universiti Teknologi Malaysia.

INTRODUCTION

Solid waste is a serious environmental problem in both developed and developing countries. In recent years, most developing countries have started to improve their municipal solid waste management practices. The increasing amount of wastes generated by rapid urbanization in these countries is usually not properly managed. Solid waste management systems in developing countries must deal with many difficulties, including low technical experience and low financial resources which often cover only collection and transfer costs, leaving no resources for safe final disposal (Moghadam et al., 2009).

Municipal solid waste (MSW), commonly known as trash or garbage consists of everyday items such as product packaging, grass clippings, furnitures, clothing, bottles, food scraps, newspapers, appliances, paint and batteries. If not dealt with properly, waste can create serious environmental and health problems. (ErhanErkut et-al 2008)

Figure 1: Scattered waste by monkeys in UTM (Source field survey, 2010)

Table 1: Facts and Figures (Asset and Development Department UTM, 2010)

Description	1996	2000	2007	2009
Campus area (in hectares)	1145	1145	1145	1145
Build-up area (in hectares)	270	280	490	600
Estate area (in hectares)	404	394	184	74
Numbers of building	295	455	512	520
Gross Floor area (in m2)	517,000	550,000	893,000	893,000
Road Length (in km)	22	25	37	37
No. of collection centres				82
Population				35,000

Improper management of solid waste has been reported by several researchers in different cities of developing countries (Sharholy et al., 2008; Imam et al., 2008; Chung et al., 2008; Berkun et al., 2005). Inadequate management of solid waste in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses (Sharholy et al., 2008)

SOLID WASTE MANAGEMENT IN UTM

During the year 2009 the waste generation in Universiti Teknologi Malaysia (UTM) Skudai campus is between 14-15 tonnes per day but with increase population, build up areas and other infrastructures the quantity of waste has increased to about 16 tonnes per day source (OAD UTM, 2010), in which if not well managed and disposed, it may pose to: (a) Potential risks to human health and that of other living organisms (b) Environmental effects (CO_2 and CH_4 methane gas emission) and (c) Increase in cost implication.

However, a lot of millions of ringgits were being spent yearly on these waste generated within UTM. To reduce the cost implication and at the same time eliminate the potential risk to both human and other living organisms, the environmental engineers and the facilities managers should directs attention to development and application of integrated disposal techniques in UTM for a sustainable waste management environment, therefore this study is meant to determine the current status of waste disposal system and to improve it within the university.

Office of Assets and Development (OAD)

The Office of Asset and Development (OAD) is responsible for campus planning and development, facilities management and maintenance, upgrading and renovation works, as well as contracting out the solid waste management services, space and vehicle booking services to a population of approximately 35,000 staffs and students. The Contract division is a new division established independent of other divisions to manage matters related to procurement and contractual agreements in Universiti Technologi Malaysia through Office of Asset and Development, which as well involved the solid waste management contractual agreement which was given to ZAQUIN ENTERPRISE Kampung maju jaya, Johor. (Facts and figures, UTM 2010).

The exert numbers of UTM land use and area in hectares, the build- up areas were also been specified by the total number of building in the university from the year 2006 to year 2009. With an estimate build-up areas of 270, 280, 490 and 600 respectively having highest number of build-up areas in the year 2009. With the above statistics these show that in terms of infrastructural facilities UTM was not left behind. However the higher the numbers of the build-up areas the more waste the environment will be generating. The facilities to be included in every build-up or built environment include Estates, buildings such like Houses, Hostels Faculties and Departments, classes, Labs, workshop seminar rooms, Stalls and shops Restaurants Public conveniences etc.

SOLID WASTE GENERATION & CHARACTERISTICS

Francheti, (2009) pinpoint that, from the global standpoint, the evolution of solid waste management has folded humankind's development and progress as it transitioned from an agricultural base, through the industrial revolution, and now to the information age. As societies addressed the critical waste management needs that were associated with these transitions, methods policies, and regulations were created to keep pace. The earliest documented solid waste management regulation dated back to 3000 B.C., in Cretan capital, Knossos. This and other policies and events associated with the evolution of solid waste management are provided in this paper.

However, the transition of the solid waste management movement revolved around two initiatives; first, (a) The protection of public health and (b) A shift to protect the environment.

The following is the brief general timeline of these movements and the remainder of this section highlight the major events during each movement.

What is a Solid Waste Management?

For as long as people have been living in settled communities, the accumulation and dumping of rubbish, or garbage, has been a significant issue. The disposal of items that are spoil, degraded, expended or simply no longer of use to the owner has become an increasingly important issue as large, modern societies generate far more rubbish than historically much smaller and less densely concentrated populations. Commonly known as 'solid waste' – to distinguish it from waste that is liquid or can be disposed of through pipes – this type of refuse requires systematic management to minimize undesirable impacts on people and their environment. Early solid waste management consisted of digging pits near either temporary or permanent dwellings and burying the refuse. While this phenomenon engages the interests of archaeologists and others attempting to determine the kinds of lives that people lived, growing populations and increasingly urban lifestyles made this practice unsustainable.

Environmental and health impacts of MSWM

Ayomoh *et-al*, (2007). Pinpoint that, the 21st century has experienced heightened economic activities due to the industrial civilization that has characterized countries worldwide. Ziadat and Mott (2005), note that the progression of modern civilization and associated continuous increase in population worldwide contribute significantly to the increase in the quantity and variety of waste generated. The ever-increasing consumption of resources results in huge amounts of solid wastes from industrial and domestic activities, which pose significant threats to human health (Frosch, 1996). Sangodoyin and Ipadeola (2000), continuing advancement in science and technology is also, contributing significantly to the increasing volume and toxicity of waste generated (Sangodoyin and Ipadeola, 2000). For example, advancements in aviation technology have led to an increasing number of people patronizing airports and airline services. Consequently, the aviation industry worldwide has a reputation for being a major polluter with airports perceived to have negative environmental effects in terms of waste production (Pitt et al., 2002). Wastes are usually classified into different categories such as biodegradable wastes and non-biodegradable wastes. Further classification based on source could be categorized as municipal (residential and commercial), industrial, and construction and demolition wastes. This paper focuses on municipal solid wastes.

Problems of Uncoordinated Disposal of Solid Waste

According to UNDP, (2008) lamented that if solid wastes are not managed properly; many risks and hazards for human welfare can result, although the relative importance of each depends on local conditions.

Uncollected wastes block drains, cause floods, create insanitary conditions, and are an aesthetic nuisance; discarded cans and Tyre encourage the breeding of flies, mosquitoes and other vectors that spread disease; uncollected or inappropriately dumped or decomposing waste attracts rodents that cause damage and spread disease, and aerosols and dust spread fungi and pathogens; open burning of waste causes air pollution including the release of toxins such as dioxin. Hazardous wastes pose risks of injury and poisoning; Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of groundwater and waterways; Waste inefficiently disposed of is an aesthetic nuisance because of its unsightliness and unpleasant aroma. Landfill gas (especially methane) from decomposing waste can be explosive, and constitutes a serious greenhouse gas emission; Former disposal sites provide a dangerous, unstable foundation for large buildings.

Institutional Level

Institutions, such as government agencies, universities, hospitals, and private companies often employ many staff and generate significant quantities of solid waste. Proactive institutions often take an active role in managing their municipal solid waste, from avoidance through disposal. An institution often has a strong interest in the activities that take place within their organization and indicators are used to monitor these achievements. This information can be used to complete the scoreboard for the Institutional Level.

UTM Sustainability Policy

The policy shall ensure that UTM functions as a sustainable campus community through responsible and optimized resource management; innovative environmental and Eco-system management and leadership commitment and campus-wide participation.

Within its own capacity, UTM aspires to demonstrate the showcase of a sustainable community amongst which are: (a) Adopting green building and infrastructure design through a clear sustainable development framework to achieve cost effectiveness. (b) Achieving efficiency in operational management of resources and facilities. (c) Strategize the provision of adequate financial resources to ensure the smooth implementation of the policies. (d) Minimizing waste and pollution through effective waste management. (e) Introducing more local flora and fauna to protect and enrich biodiversity. (f) Maintain a healthy balance between developed and green areas to achieve campus Eco-system vitality. (g) Promoting low-carbon practices among campus community. (h) Eliminating non-biodegradable food and beverage packaging.

This policy shall be adhered to and implemented through extensive and focused initiative throughout the university's organizational structure and activities. (OAD. 2010)

Figure 2: Waste collector within UTM (Source field survey, 2010)

Figure 3: Solid Waste Management Hierarchy (UNEP, 2004)

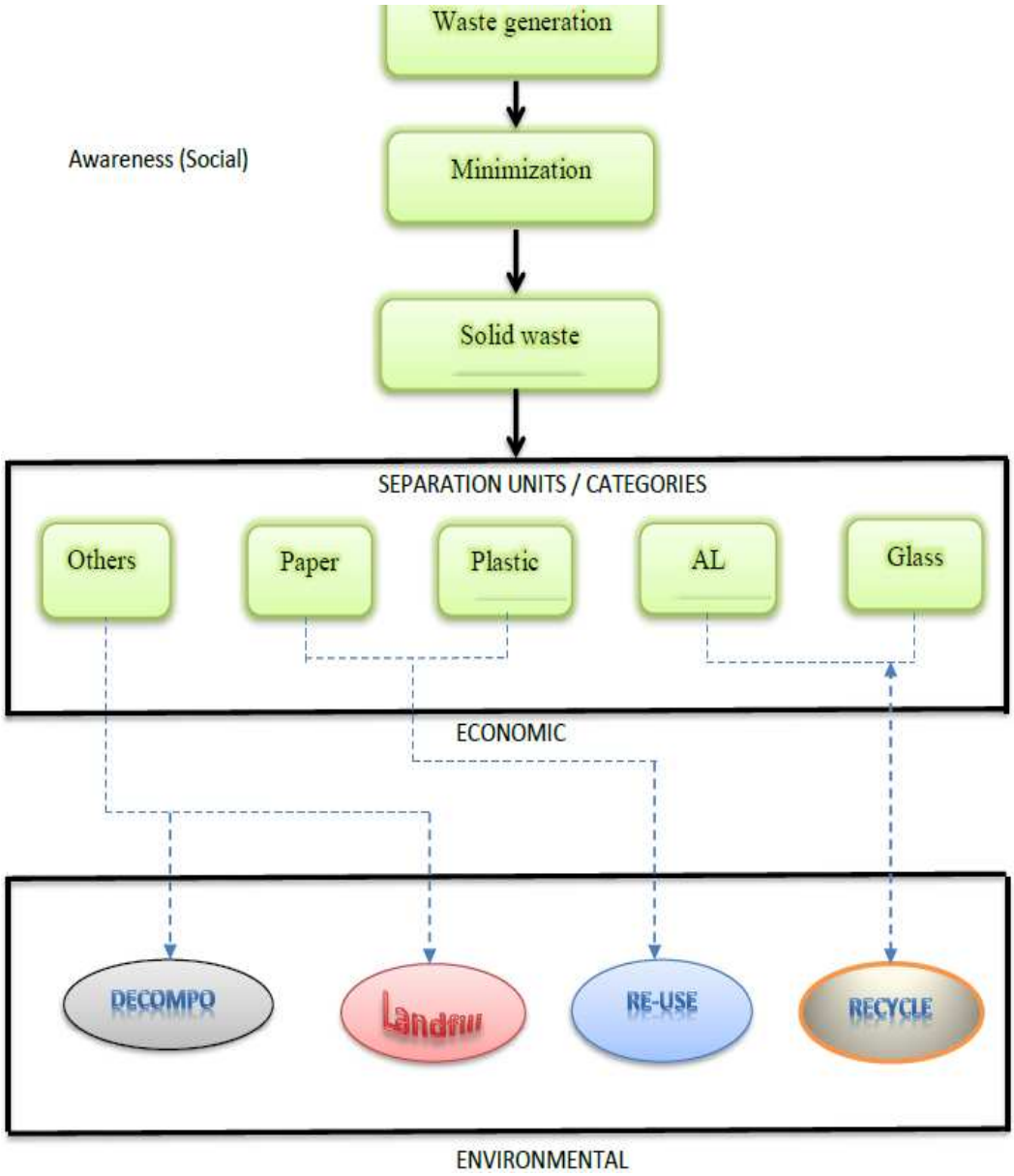

Figure 3: Integrated solid waste management model for Universiti Teknologi Malaysia

WASTE MANAGEMENT HIERARCHY AS A KEY ELEMENT OF INTEGRATED SOLID WASTE MANAGEMENT

The waste management hierarchy is a widespread element of national and regional policy and is often considered the most fundamental basis of modern MSWM practice. The hierarchy ranks waste management operations according to their environmental or energy benefits. In virtually all countries, the hierarchy is similar to that shown in figure 3, with the first entries having higher priority than those below them. (UNPE, 2004)

The hierarchy is a useful policy tool for conserving resources, for dealing with landfill shortages, for minimizing air and water pollution, and for protecting public health and safety. In many developing countries, some aspects of this hierarchy are already in place, since traditional practices revolving around waste prevention reuse, and recycling are prevalent. At the same time, it should be recognised that all waste management practices have costs, as well as benefits. This means that the hierarchy cannot be followed rigidly since, in particular situations, the cost of a prescribed activity may exceed the benefits, when all financial, social, and Environmental considerations are taken into account. (UNPE, 2004)

Waste Reduction/Avoidance

Institutions can provide an ideal showcase for waste reduction/avoidance initiatives. These may include purchasing programs that require recycled content and other similar programs. As a result, scoreboard points should be awarded for each activity based on the comprehensive nature of the waste reduction/avoidance programs that are established at the institutional level. A maximum of 100 points has been allocated for this category. UNEP, (2005)

Storage and Collection

Storage and collection of solid waste at institutions are generally handled by private contractors. IWM Scoreboard points at the institutional level should be awarded based on whether the organization has successfully implemented a waste storage collection program. For example, are different containers provided for different waste types (such as at hospitals), are standardized containers used, are the containers placed in the designated collection points at the designated times, etc. A maximum of 100 points has been allocated for this category. UNEP, (2005)

Resource Recovery

At the institutional level, Integrated Waste Management Scoreboard points should be awarded for each of the various resource recovery activities including recycling and composting. These activities may include recycling of office paper, recycling of printer cartridges, composting of food scraps, composting of green waste from landscaping maintenance. Combustion with heat recovery may be used at larger institutions. Points should be allocated based on the percent of the institution's total waste stream that is managed by these programs and facilities. A maximum of 200 points has been allocated for this category. UNEP, (2005)

Disposal

Institutions are generally not directly involved in operating landfill disposal facilities. If this is the case, IWM Scoreboard points should be awarded for based on the present of the total waste stream that is currently being managed at modern disposal facilities (rather than open dumpsites). However, it is recognised that some larger institutions may operate their own disposal facilities. In this case, IWM Scoreboard points could be awarded for based on the performance of their disposal program. If applicable, told disposal sites that are under the direct control of the institution that have been properly closed should be reviewed. A maximum of 200 points has been allocated for this category. UNEP, (2005)

Public Awareness/Education

At the institutional level, IWM Scoreboard points should be awarded for based on the establishment of programs that raise awareness of staff regarding solid waste management issues and practices. These programs may include orientation of new staff, training, internal promotion, participation in industry programs and awards events, and reporting of achievements. A maximum of 100 points has been allocated for this category. UNEP, (2005)

CONCLUSIONS

Even though the current system of Integrated solid waste management was developed somewhat as a result of environmental issues and cost reduction as it was emerged in early 1990's. Most of the Organizations and communities does not use the integrated system of managing their waste generated, as such it leads to the potential risk to human and other living organisms as well as increasing the level of threats to global warming as CO_3 and CH_4 gas was emitted and increasing the cost implication. However Integrated Solid Waste Management, design the systems approach which will help to reduce the environmental impacts in both the long and short time planning. As the markets of recyclable materials fluctuate with time, the next research could find the necessary adjustment to fund the allocation for running a further research on reuse, recycle and incineration to generate energy rather than disposal as an option.

Certain problems can be more easily resolved in combination with other aspects of the waste system than on their own. Also, development of new or improved waste handling in one area can disrupt existing activities in another area unless changes are handled in a coordinated manner. Integration allows for capacity or resources to be optimized and, thus, fully utilized; there are frequently economies of scale for equipment or management infrastructure that can be reached only when all of the waste in a region is managed as part of a single system.

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REFERENCES

[1] Ayomoh M.K.O., (2007*) An approach to tackling the environmental and health impacts of municipal solid waste disposal in developing countries*, Journalof Environmental Management vol. 88 pp 108–114

[2] Berkun, M., Aras, E., Nemlioglu, S., (2005). *Disposal of solid waste in Istanbul and along the Black Sea coast of Turkey*. Waste Management 25, 847–855.

[3] Bilgili M.S., Ahmet Demir, Bestamin O¨ zkaya. (2006) *Influence of leachate recirculation on aerobic and anaerobic decomposition of solid waste, science direct* journal of hazardous materials vol: 143, pp 177-183

[4] Cointreau, S., (2006). Occupational and Environmental Health Issues of Solid Waste Management: Special Emphasis on Middle and Lower-income Countries. World Bank, Washington, DC).

[5] Daronlavee et-al.,(2009) *The effect of recycling price uncertainty on municipal waste management choices.* Journal of environmental management, scince direct vol: 90.

[6] Erhan Erkut, Avraam Karagiannidis, George Perkoulidis, Stevanus A. Tjandra (2008). *A multicriteria facility location model for municipal solid waste management in North Greece.* European, Journal of Operational Research 187 (2008) 1402–1421

[7] Frosch, R.A., (1996). *Toward the end of waste: reflections on a new ecology for industry*. Daedalus 125 (3), 199–212.

[8] Gijzen, H.J., (1997). *Duckweed based wastewater treatment for rational resource recovery. In: Proceedings of the VII CongresoNacional de Biotecnologia Bioingenieria*, II Symposio Internacionalsob reIngenieria de Bioprocesos, Mazatlan, Mexico, 8–12 September 1997, p. 39.

[9] Issam A. Al-Khatibetal (2010). *Solid waste characterization, quantification and management practices in developing countries*. A case study: Nablus district Palestine, Journal of Environmental Management 91 (2010) 1131–1138

[10] M.R. Alavi Moghadam N. Mokhtarani, B. Mokhtarani (2009) *Municipal solid waste management in Rasht City, Iran,* Waste Management Vol. 29, pp. 485–489 Elservia.

[11] Olorunfemi, J.F. and Odita, C.O. (1998), *"Land use and solid waste generation in Ilorin, KwaraState Nigeria", The Environmentalist*, Vol. 18, pp. 67-75.

[12] Pitt M. Brown. A. Smith A., (2002). *Waste management at airports facilities* 20 (5/6), pp 198-207

[13] Sangodoyin, A.Y., Ipadeola, S.F.,(2000). *Hazardous wastes: assessing the efficacy of structures and approaches to management in*

Nigeria. Environmental Management and Health 11 (1), 39–46.

[14] Sharholy, M., Ahmad, K., Mahmood, G., Trivedi, R.C., (2008). *Municipal solid waste management in Indian cities* – A review. Waste Management 28 (2), 459–467.

[15] Sharholy, M., Ahmad, K., Vaishya, R.C., Gupta, R.D., (2007*). Municipal solid waste characteristics and management in Allahabad India*. Waste Management 27, pp490–496.

[16] Ziadat, A.H., Mott, H., (2005). *Assessing solid waste recycling opportunitiesfor closed campuses*. Management of Environmental Quality: An International Journal 16 (3), 250–256.