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Development of a Model for Municipal Solid Waste Management at Residential Area for Case Study in Kamunting, Perak Using Web Development

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Abstract: Environmental and pollution issues are alarmingly increased each year as Malaysia moved forward to achieve high-income country in current national plan. One of the main concerns to look upon is solid waste management and final disposal thereof. As such, district of Ipoh, Perak, produces 0.85 kg/capita per day of waste and keeps increasing each year at a rate of 5.4%. This rapid increment acquires structured and well-managed plan to handle the solid waste disposal. A handful of reports stated that the waste collector practices are not undertaken as previously instructed which lead towards abundance and excessive deposit of waste at collection checkpoint. Thus, this calamity needs to be solved by producing a tool on how to manage the solid waste disposal via the use of web-based program. The existing guidelines are embedded within the newly proposed web-based program, so that practitioners and ordinary citizen can peruse and look upon on how to manage the solid waste at their convenience. The main aims of this research are to identify the composition of municipal solid waste in Ipoh, Perak and to develop a model of municipal solid waste management using XAMPP web-based program. User-defined functions were created into the PHP interface enabling the users to click the menu on the main screen. Prior to this web development, questionnaires and interviews were carried out to gather the primary data on the solid waste composition at the district of Ipoh, Perak. The model development is commenced after getting enough and reliable data pertaining to solid waste composition thereof. The development of web-based model for Ipoh district is expected to help practitioners and residents to identify the composition of waste and best management practice at their community.

Key words: Waste management, disposal, web development, expected, community

INTRODUCTION

The slogan for sustainable development encompasses of achieving national and economical agenda whilst not scarifying the beauty and uniqueness inheritance that we have had for many decades. In our pursuit towards developed country status in year 2020, cleanliness has become important parameter in determining the maturity of our civilian. There is no use of having booming infrastructures and facilities if the way of thinking and acting is still at 20-30 years behind. Thus, to make sure this parameter (cleanliness aspect) is at the top niche, the management of this issue must be treated as a top priority. Every year, an approximate 11.2 billion tonnes of solid waste is collected worldwide and the process of decaying solid waste contributes 5% of global greenhouse gas emissions. In Asia, the management of waste materials requires immediate attention especially in China, South Korea and Malaysia which have been regarded as emerging industrialized countries (Badgie *et al*., 2012).

Report by (Badgie *et al*., 2012) stated that estimation rate of waste generated in Malaysia will increase to 1.4 kg/capita/day in 2025. This is due to the fact that more civilian will migrate to cities and the city area will become dense with population in coming years. Table 1 shows the current generation of solid waste in Malaysia stood at kg/capita/day (as 2011). The urban population comprised 53.7% from overall population in Malaysia. However, it is projected that urban population will increase to 72.7% in 2025 and the solid waste generation will exponentially rise to 1.4 kg/capita/day (Table 2).

Poor waste management such as ineffective collection and disposal system can cause air pollution, water and soil contamination. Open and unsanitary landfills contribute to water contamination and may affect

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Table 1: Waste produced by country in year 1995

Country	GNP per capita (1995 US$)	Current urban population (% of total)	Current urban MSW generation (kg/capita/day)
Myanmar	240	26.2	0.45
Vietnam	240	20.8	0.55
Laos	350	21.7	0.69
Indonesia	980	35.4	0.76
Philippines	1050	54.2	0.52
Thailand	2740	20.0	1.10
Malaysia	3890	53.7	0.81
Singapore	26730	100.0	1.10

Table 2: Estimation waste produced by country in year 2025

Country	GNP per capita (1995 US$)	2025 urban population (% of total)	2025 urban MSW generation (kg/capita/day)
Myanmar	580	47.3	0.6
Vietnam	580	39.0	0.7
Laos	850	44.5	0.8
Indonesia	2400	60.7	1.0
Philippines	2500	74.3	0.8
Thailand	6650	39.1	1.5
Malaysia	9400	72.7	1.4
Singapore	36000	100.0	1.1

millions of civilians who wish to get clean drinking water. To make it worse, the dispersal of debris pollutes ecosystems and behaviour of oxygen sag become faster and faster. The dissolved oxygen which was originally used by fish and other aquatic life is now depleted because of oxygen demanding material. The dissolved oxygen is used to oxidize or breakdown the pollutant, hence organisms that have high oxygen demand cannot survive in the sag curve (Weiner and Matthews, 2003).

Thus, good management system must be formulated to promote healthy environment. There are a lot of methods available to treat those wastes such as recycling, composting, inert landfill, sanitary landfill and other disposal site. In Malaysia, recycling and disposal through engineered-sanitary landfill get started in 2002. Prior to this year, open burning or open disposal predominate the Malaysian practices. Table 3 shows the treatment method in Malaysia as per 2002, 2006 and estimation in 2020.

Knowing the urgency to have an effective waste management, this paper discuss the composition of municipal waste at residential area in Perak and propose a new model of solid waste management system using web development.

Literature review

Solid waste management: Solid waste management is a systematic control of waste comprising collection, storage, transport, source separation; processing, treatment, recovery and disposal of solid waste (Fig. 1). Each stage process has different functionality in order to reduce the quantity of waste (Begun *et al*., 2009).

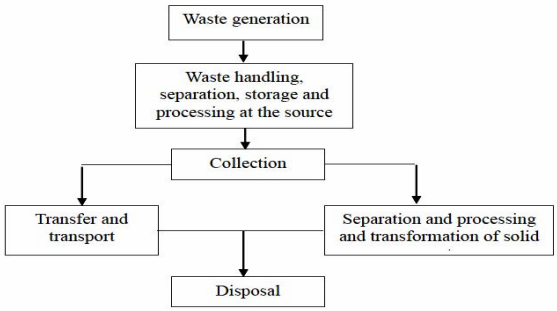

Fig. 1: Waste management process

Waste may come from various sources such as agricultural waste, industrial waste, residential waste or institutional waste. This waste can be grouped under Municipal Solid Waste (MSW) also known as trash or garbage. Durable goods such as tires, furniture and nondurable goods such as newspaper, plastic plates/cups and container is an example of municipal solid waste. Municipal Solid Waste (MSW) has five main resources which is residential, commercial, institutional, industrial and municipal.

As shown in Fig. 1, transfer and transport has become an integral part between collection and disposal stage. As currently practice in Malaysia, the collection system of Municipal Solid Waste was done using Hauled Container System (HCS) and Stationary Container System (SCS). Hauled Container System (HCS) is a container that has been placed at specific location. Full container will be picked up and hauled off to the disposal area and the container will be replacing with another empty container. Stationary Container System (SCS) is a 'static' container where it remains in the vicinity of where the waste is generated. SCS has 2 types. First type of SCS is mechanically loaded where larger containers wheeled residential pickup and commercial pickup. The second type is manually loaded where collector people will dumb the trash into pickup vehicle using small containers as widely seen in the residential area.

By emulating current practices, it is high time to develop a model to assist authority or practitioners to manage the solid waste disposal. Prior to the model development, it is very crucial to understand the composition of solid waste in Kamunting, Perak and intensity of waste generation which can reflect to the best choices of collection or transferring method.

Web development system: Web development is a process to develop website to be use on Internet (World Wide Web) or Intranet (Private Network). For basic internet usage, website must consist its own name called domain

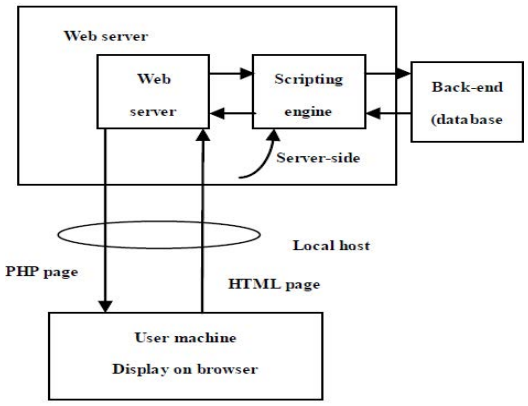

Fig. 2: Web system

with domain extension such as dot com, dot net, dot org and another domain extension. The main domain is depends on developer and usually related to web content. The simplest form of website is a static webpage and it is developed using Hypertext Markup Language (HTML) as a language code. This static webpage is designed to share information to worldwide user. The data may be in the form of text, graphics, audio or video format (Norizawati, 1999). Additional Cascading Style Sheets (CSS) are used to control appearance of webpage and user only can read the information, watch video and listening music from what has been shared by developer. Static page that are consist of HTML and CSS language can be run using web browser.

Nowadays, website can be developed by using a variety of programing languages such as HTML5, Hypertext Preprocessor (PHP), Active Server Pages (ASP), Ruby and other web programming language. All these programming language has made websites more attractive and it not only for information sharing, but it also can be used for business, gaming website, file sharing and websites providing various other services. The programing language has more complex as compared to static web page. Besides that, all of these languages can be connected to the database server that gives advantages to user to interact with the developer or another user. However, these are specific software required to run the website by using these complex programming language.

XAMPP is one of software that required converting basic computer into server computer. This software is able to provide necessary database by using PHP language in computer. Figure 2 shows the relationship between server, database, web programming and browser.

Application of web development system: Regarding to the previous study, there are some researchers that started to develop solid waste management modelling by using development system to delivering information purposes only. The application by Geisler was given a visualization of proper processing municipal solid waste only for authorities. Using the application, the user can receive and organize the waste forecast data from across the complex and automatically have an ability to forecast generate waste data in tables format and other displayed report.

In 2012, Idowu *et al*. (2012) has created a model for Nigeria based on the observation daily progress of waste management. The system was suitable to be accessed through desktop or laptop with the large resolution and less user friendly for mobile.

The application was widely used and has been improved by Thompson *et al*. (2013). Using the same approach, Thompson designs the system for society and authority with messaging process or report any problem regarding waste management purposes. These notifications are gathered from discussion forums, direct messages and short messages (SMS) logged on to the application (Thompson *et al*., 2013). Society has ability to login and send messages to the authority.

As compared to the modelling for this research, the web application was designed for authority to record the data of waste management and progress work. This web application also include information as a knowledge and awareness for public about appropriate approach of municipal solid waste management in area Perak. Besides that, people also can report any problem regarding waste management issue through this application. The area was chosen as a case study based on numbers of waste production and the level of awareness society about solid waste management.

Besides that, authorities also have ability to analyze the collection process of waste according to the type of collection, either HSC or SCS. Authority also can determine the suitable collector by depend on type of waste selected. It gives opportunity for the district in Perak to developed systematic approach as modern as Kuala Lumpur in order to achieved Malaysia mission.

MATERIALS AND METHODS

To achieve the first objective, 3 approaches were applied in order to get the information on the composition of solid waste generated in Kamunting Perak. Those approaches can be concluded such as having discussion with the authority, executing 'online' and 'offline' questionnaire (Google forms and questionnaire sheet) and live interview with the residents at nearby area.

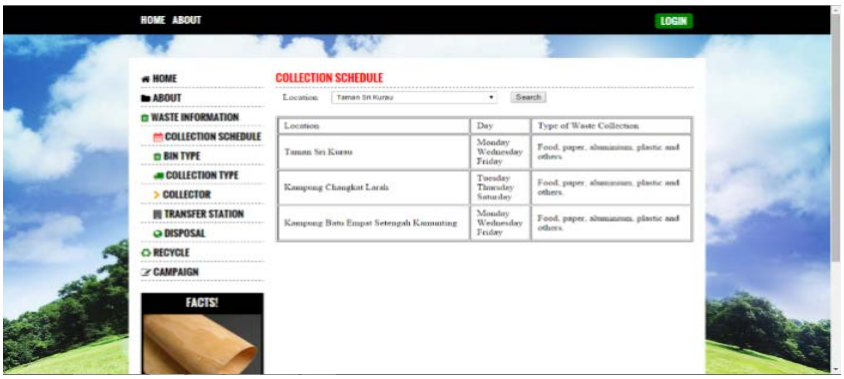

Fig. 3: Main user interfaces

Discussion with the waste management authority can extract the data such as suitable trucks, type of disposal method and many more. Set of questionnaires and scheduled interviews were carried out to get input on the consumer's awareness towards solid waste management and other related matters.

For the second objective, web based development was formulated using XAMPP's Software. This software will interpret scripts written in Hypertext Preprocessor (PHP) interface and provide the users with much more flexibility and ease towards applying the model.

RESULTS AND DISCUSSION

Thus far, 40 respondents took part in the questionnaire program. Out of this 40, 32.5% (13) are male while 67.5% (27) are female. The teenager (age between 18-24 years old) is the majority of the participants comprising 40% of the respondents. Most of the respondents live with either 3 or 4 people per household signifying the average generated waste opposed to the dense population area. From 40 respondents, 85% were active internet subscribers and 15% do not subscribe or possess any internet plan. Almost all the respondents (97.5%) agree that internet is the source of information especially the information pertaining to solid waste management. This agreement provides vital information about the suitability and effectiveness of having a web based program for solid waste management.

To deduce the intensity of generated waste, five classes are formed namely None, Too Little, Little, Much and Too Much. The results in Table 4 show that food and plastic become highest waste generated in residential area in Kamunting Perak and followed by paper, bottle, aluminium and others. It is understood that rubber and glass waste do not generated in this area. Since, food and plastic become the highest proportion of solid waste, thus it is best either to dispose the waste (especially food) or recycle the used paper for other purpose. When it comes to recycle part, half of the respondents do not know the concept of recycle. Even more than half of the respondents do not know the functionality of recycle bin. More than 80% agree that efficiency of solid waste management lies on the basic knowledge of solid waste, its processes and practicality to dispose the waste. This finding acquires a tool and mechanism to help consumers understand the concept of recycle as well as comprehending the pillar of solid waste management.

Table 3: Waste treatment methods practiced in Malaysia

Treatment methods	Percentage (%) 2002	2006	Target 2020
Recycling	5	5.5	22.0
Composting	0	1.0	8.0
Incineration	0	0.0	16.8
Inert landfill	0	3.2	9.1
Sanitary landfill	5	30.9	44.1
Other disposal sites	90	59.4	0.0
Total	100	100.0	100.0

Table 4: Type of waste generated at residential area in kamunting

Type of waste	Sequence None	Too little	Little	Analysis Much	Too much	Mode	Median
Food	0	5	9	23	3	4	4.0
Paper	2	12	23	2	1	3	3.0
Alumini	9	18	13	0	0	2	2.0
Bottle	2	16	20	2	0	3	3.0
Plastic	4	10	10	13	3	4	3.0
Rubber	18	15	7	0	0	1	2.0
Glass	20	16	4	0	0	1	1.5
Others	10	15	11	4	0	2	2.0

Web application: The web development consists of 6 menus namely collection schedule, disposal method, type of bin, art of recycle, analysis menu and analysis collection (Fig. 3). For collection schedule, users are provided with a drop-down list for a specific area; so that resident may alert the time that collectors will arrive. Type

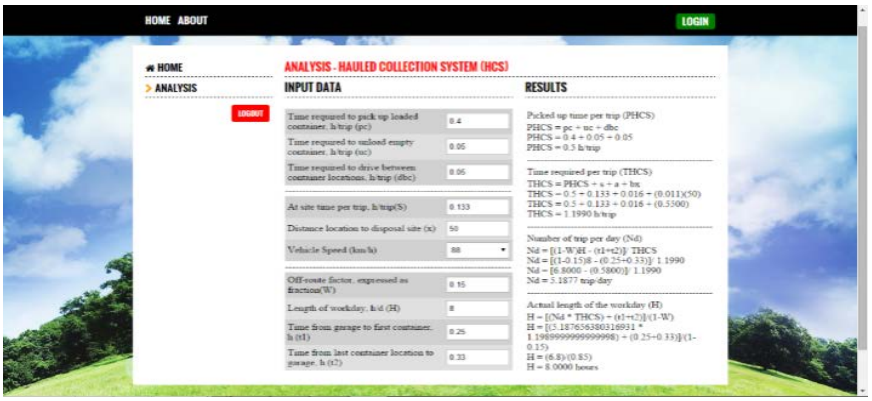

Fig. 4: Analysis menu

of bin menu portrayed three types of commonly used bin in waste management which are curbside bin, RORO bin and Recycle bin. These bins should be used with different type of waste. For example, curbside will be used for plastic, food, paper or aluminium waste. Recycling section consist of waste materials that can be recycle, location of recycle facilities and alternative way to reuse the waste materials. Last section for this web-based program is analysis menu consist of analysis collection. This section is reserved for authority to log in. After the log in, waste collection system can analyses either using Hauled Collection System (HCS) or Stationary Collection System by click the image category (Fig. 4).

CONCLUSION

The finding shows that the highest waste compositions at residential area in Kamunting Perak are food and plastic. However, residential awareness towards waste management is still lacking. By using this web application, users will learn the process of waste management. Users will be equipped with the alternative way to reuse the waste materials in recycle section. Besides that, schedule of waste collection is provided and quite helpful as a preparedness tools to residents who are living nearby. Interactive of built-in menus have the ability to help the authority to design the waste collection process via HCS or CSC method. This analysis was provides the users with appropriate time that required for truck to picked up per trip and numbers of trips waste collector per day. Since, this web-based is still at initial stage, further enhancement and extension are needed in the future.

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