



Dynamical Integrated Framework Development of Solid Waste Management in Malaysia

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Abstract

The paper is an illustrated of the framework development on dynamical integrated solid waste management in Malaysia. The framework is consisted of four stages. First stage is an essential study done by authors for understanding the solid waste management process and identifying the related issues by engaging an expert of the field and previous studies. Second stage is highlighted the important of predicting an adequate quantity of the waste generation in Malaysia. The prediction process applied a multilinear regression analysis. Third stage presented a development of integrated dynamical solid waste management model using system dynamics simulation. In the final stage, a user interface is constructed for assisting an operational level to monitor the progression of their performance on strategic plan. This summary conceptual framework represents the holistic framework which significantly assist the operational department for monitoring the solid waste management process efficiently and comprehensively.

Keywords: Solid Waste Management; Dynamical Integrated; Conceptual Framework Development.

1. Introduction

Waste generation is becoming an alarm worldwide including developing country such as Malaysia. Developing country always look for improvement and strategy for overcome this issue. The main issue in solid waste management is the increment of quantity of waste generation [1-3]. This challenge is due to rapid population, development process, urbanization, migration, income level and society involvement. In Malaysia, the waste was generated an approximately 1.5kg/person/day to 1.8kg/person/day in 2012 [4] and this scenario continuously rise annually. As projected in 2016, the waste generation had reached more than 25000 metric tonnes of domestic waste per day [5]. At present, the quantity of waste generation rise tremendously to more than 33000 tonnes/year, which is this amount was predicted to be happened in 2020.

Inefficiency of solid waste management give huge impact on the ecosystem and sustainable environment for future. For example, plastic waste requires thousands of years to disassemble. This will increase the emission of harmful greenhouse gas (GHG). More than 25,000 metric tonnes of waste generated daily, and food waste contributes the highest percentage of 45%, followed by 24% are plastics. 18% of waste composition are glass and 11% are consist of paper and metals and others. Present practice in Malaysia, 95% of the waste generation are disposed at landfill area. In Malaysia, total of 296 landfills, where there 165 landfills are active and 131 are inactive. Moreover, there are 8 sanitary landfills and 3 are categorized as inert landfill. Yet, almost 80% of these landfills have reached full occupied capacity and are expected to be closed over the next few years [5, 12-14].

2. Literature Review

Solid waste management is a complex and crucial task around the world, including Malaysia. The complexity increases due to rapid population, urbanization process and economic development. Changing life style has influent the transition of waste generation trend. In urban area, the waste generation tremendously increase compared to rural area. This scenario will impact the efficiency of solid waste management process such as waste collection and waste disposal. Lack of systematic approach will increase environmental pollution and risk of disease to the society [6, 8, 15-17].

Malaysia is a tropical country in South East Asia with a land area of 329,847km². The country is separated into two regions (West and East Malaysia) which Kuala Lumpur is the capital city. The population in Malaysia was 31.19 million people in 2016 and this number is expected to increase around to 32.04 million in 2018. Due to this tremendous, the solid waste management in Malaysia face some huge challenges because the complexity of the solid waste management process and huge increasing amount of waste generation [9]. Table 1 shows the challenges in solid waste management in Malaysia.

In Malaysia, the government and solid waste management authorities has launched several initiatives program on recycling campaigns. This initiative received an involvement from public's participation, non-government organization, institution, school to spread the importance of recycling activities. Only 5% of recycle rate has been recorded in 2005. This recycle rate increase to 10.5% in 2012. As in 2016, the rate of recycle show a positive rise to 17.5% and perhaps in 2020 the target of 22% of recycling rate can be achieved [7-8, 12].

Table 1: Challenges in Solid Waste Management

| Challenges | Descriptions |
|--|---|
| Insufficient technologies and facilities | Solid waste analysis and data for major towns and cities basically have not been well documented. |
| Public Awareness and Enforcement | Low awareness programs and awareness campaigns. |
| Recycling Program | Moderate recycling practice level. |
| Landfill Capacity | Landfill capacity cannot accommodate the quantity of waste. |

Malaysia’s solid waste management has several strategies which able to improve the environmental quality, public health, and socio-economic development. These strategies are in line with the vision 2020, Malaysia as a sustainable ecofriendly and green environment nation. Thus, a solid primary requirement is needed to increase the effectiveness and efficiency of solid waste management by ensure of achieving the target set with an integrated and sustainable perspective by participating from the local, state, and federal governments.

3. Methodology

This framework is developed in order to illustrate a propose process flow of an integrated dynamical sustainable solid waste model. This framework is consisting of four stages as shown in Fig. 1.

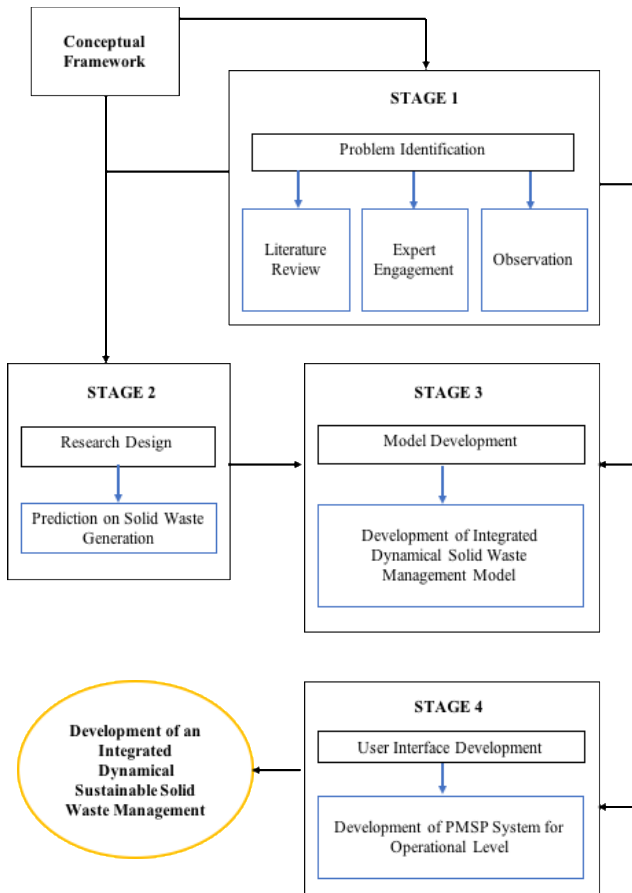


Fig. 1: Proposed process flow

3.1. Problem Identification

Firstly, the identification of issues that related to the solid waste management in Malaysia. Several discussions with the authority parties had done based on interviewing an expert in the field of knowledge. Some issues are highlighted from literature review based on previous discovery as shown in Fig. 2. In stage 1,

background of study exploration and problem identification [10-11]. Literature search had been done by author in order to understand the nature of the field of study from previous researchers [6, 9].

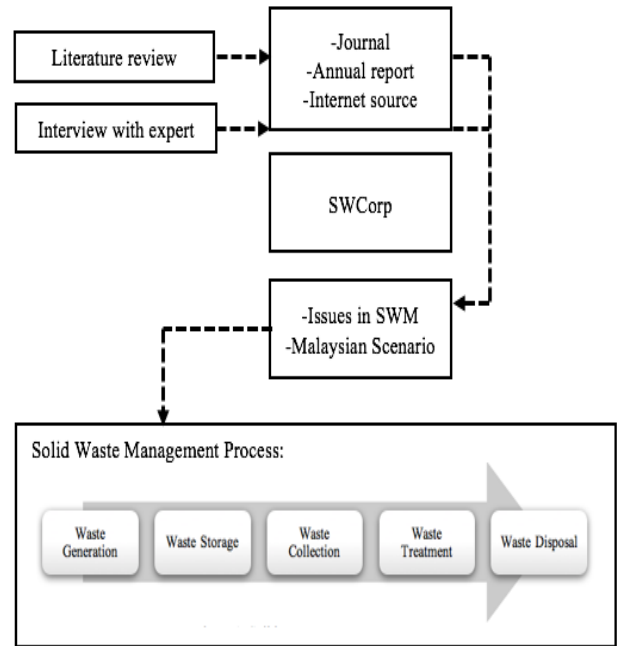


Fig. 2: Stage 1

3.2. Prediction on Solid Waste Generation

Lack of data adequate and inefficient of system monitoring specially to measure the strategic planning achievement that set by the authorities of Malaysian solid waste management. The main problem in solid waste management is waste generation. The quantity of waste generation is rise annually and becoming an alarm to nationwide. Conventional method to handle this issues by sending the waste to the dumping area. However, due to limited capacity of each landfill may cause harmful environment. This scenario motivates the author to conduct a prediction analysis on solid waste generation in stage 2 as in Fig. 3. A multilinear regression analysis adapted to predict the solid waste generation (dependent variable) based on population, gross domestic product (GDP), employment rate and energy usage (independent variables) [1]. The result from this multilinear regression analysis is expected to help the management level to predict the future solid waste generation. Statistically, the prediction output will increase the efficiency and level of accuracy of the data.

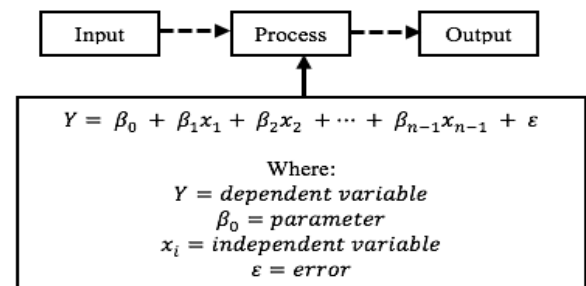


Fig. 3: Stage 2

3.3. Development of Integrated Dynamical Model

In stage 3 (Fig. 4), an integrated dynamical model is developed using system dynamics simulation. This model accommodates a solid waste management process as a holistic process. System dynamics received a great attention by researchers around the world and this method has been applied since 50s by J.W Forrester in

multidisciplinary fields [2]. The application of system dynamics in solid waste management particularly for Malaysian context has not yet been established. The advantages of using system dynamics are this method is designed for catering with linear and non-linear interactions, large-scale of problem, complex environment and dynamic scenario. Due to these advantages, therefore this study is the first to embark system dynamics for developing an integrated dynamical solid waste management model. System dynamics is a continuous simulation technique which is one of an alternative optimization in decision making process.

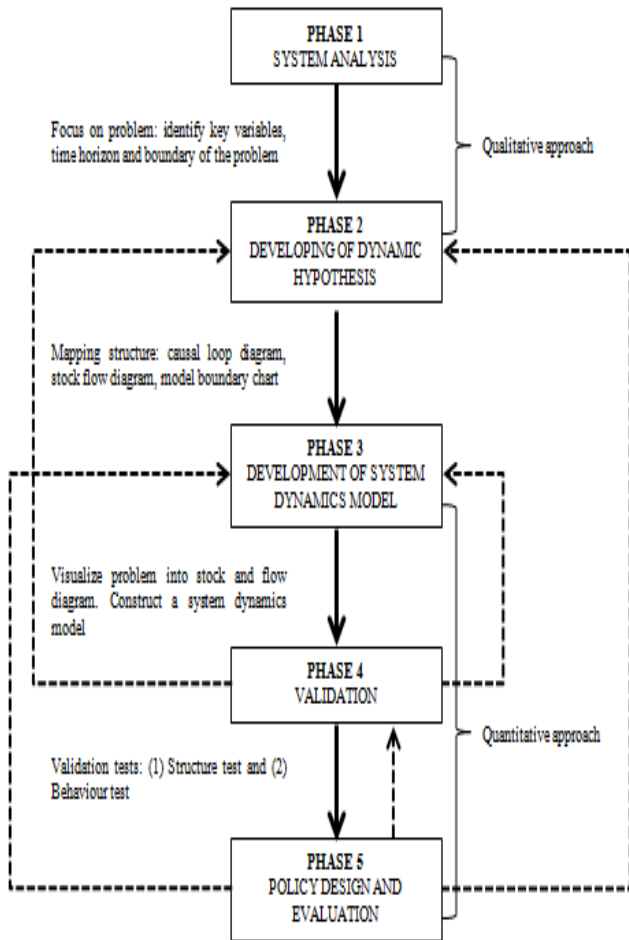


Fig. 4: Stage 3

3.4. Development of Prototype PMSP System

The development of the prototype PMSP system as a user interface can help the management to analyze the progress of the strategic plan achievement more effectively. In stage 4 as in Fig. 5 present the development of user interface which aim in helping the operational level in decision making process. The system is expected to assist the management for monitoring the performance of their strategic planning. The analysis resulting from the output of the system is expected to facilitate the decision makers in assessing the current level of achievement and also take the best steps holistically in line with the strategic planning of solid waste management plans. Through the development of this technology in line with the goals of the country to achieve social well-being and a sustainable environment.

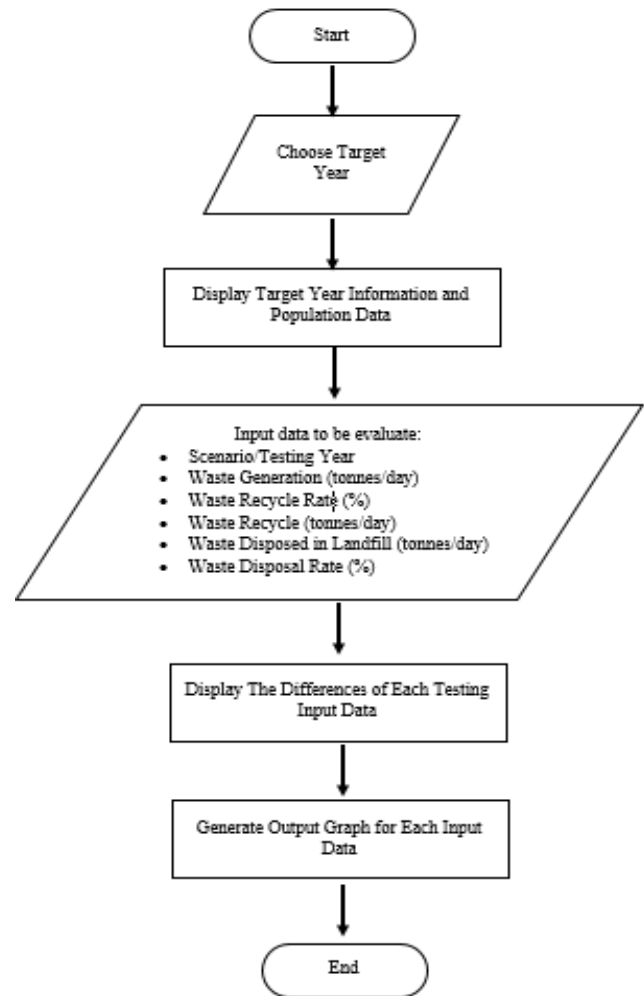


Fig. 5: Stage 5

4. Conclusion

In this paper, a holistic dynamical integrated framework development solid waste management in Malaysia is presented in order to deal with the challenges and issues that had been highlighted above. This proposed framework can help the management of solid waste holistically handle the challenges by easily cater the bottleneck issues. Moreover, it could save time and cost effective in decision making process. Consequently, this proposed framework will contribute to the enhancement of body of knowledge, provide better solution to the field of study and especially for sustainable future environment.

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