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Prototype PMSP System Development for Operational Level in Solid Waste Management

Faridah Zulkipli*
Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, Tapah Road, 35400 Perak, Malaysia

Zulkifli Mohd Nopiah
Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

Noor Ezlin Ahmad Basri
Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

Cheng Jack Kie
Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia

Muhammad Afif Zafri Khuzairi
Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, Tapah Road, 35400 Perak, Malaysia

Abstract

This paper aims to demonstrate the PMSP (Performance Measurement of Strategic Planning) System for solid waste management process. The complexity and dynamic scenarios in nature of solid waste management cause a huge implication for the management in order to thoroughly monitor the achievement of strategic planning. This condition causes the rate of generation of solid waste to increase every year. In addition, solid waste management is responsible in finding a more efficient mechanism to ensure that strategic planning plans are fully realized by the year 2020. As a result, 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. The analysis resulting from the output of the system is expected to facilitate the decision makers to assess 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 the goals of the country in social well-being and a sustainable environment could be achieved.

Keywords: Solid waste management; Strategic planning; Sustainable; User interface; Decision support system.

1. Introduction

Solid waste management is currently a critical and complex task and has become a future challenge around the globe, including Malaysia (Zulkipli *et al.*, 2016; Zulkipli *et al.*, 2017). Statistics show that the Malaysian population in 2010 has reached about 28 million people, while in 2020 the population has been predicted to increase more than 33 million people (SWCorp, 2016). The numbers has and will increase by 15% from year 2010 to 2020. The hasty population rate, rapid urbanization process and economic development contribute significantly to the waste generation quantities. This increasing trend created a critical condition for the management of solid waste. Recently, the government, local authorities as well as participant from others will be the most priorities for Malaysia to look forward to by achieving a sustainable development target in year 2020 (KPKT, 2015; SWCorp, 2016).

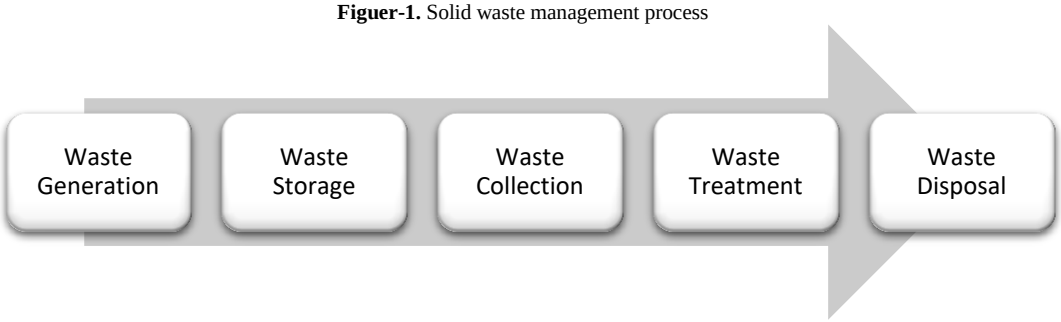
The use of strategic planning has been put in place to solve the problem. In developing countries such as Malaysia, we are faced with lack of systematic approach, insufficient technology as well as less awareness from other parties such as the public (Ahsan *et al.*, 2014; Budhiarta *et al.*, 2012; Zulkipli *et al.*, 2018). The achievement of strategic planning will be the benchmark for measuring the ongoing strategic planning which is promising to be parallel with the Eleventh Malaysia Plan (2016-2020) towards a sustainable environment, green ecosystem and balanced biodiversity (Government of Malaysia, 2006-2010; KPKT, 2017). Hence, this research is an initiative to help the solid waste management department in monitoring their achievement of strategic planning 2016-2020.

Operational level needs a systematic tool for decision making process. In current practice, the operational level used traditional way of monitoring the achievement of strategic planning. The efficiency of the monitoring practice are still lacking of computer aid system and data analysis take longer time. Therefore, this research is an initiative to improve the current practice. Hence, the objective of this paper is to demonstrate the development of the prototype PMSP System. The advantages of this prototype system are it is user friendly and cost effective. This prototype system is developed using Microsoft Excel as in terms of data storage (database) it is the most convenient and the user can use this system anywhere at any time even when there is no internet connection.

*Corresponding Author

Solid waste management (SWM) process as shown in Figure 1, is an increasingly complex task, absorbing a huge amount of resources and giving a major environmental impact. The solid waste management process is a holistic process consist of waste generation, waste storage, waste collection, waste treatment and waste disposal. Statistical report on waste composition study in 2012 shows the highest contribution of waste generation is food waste (44.5%) followed by plastics (13.2%), diapers (12.1%), paper (8.5%), garden waste (5.8%), glass (3.3%), textile (3.1%), tetrapak (1.6%) and others (7.9%), respectively (SWCorp, 2016). Due to this issue, computerized systems using operations research techniques can help decision makers to achieve remarkable cost savings as well as to improve waste recovery, which is in line with the Eleventh Malaysia Plan (2016-2020). In 2020, Malaysia is expected to achieve a sustainable environment where green growth will be a fundamental shift in how Malaysia sees the role of natural resources and the environment in its socio-economic development protecting both development gains and biodiversity at the same time

Figuer-1. Solid waste management process



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However, building a socio-economic development strategy that will increase the resilience to climate change and natural disasters remains as critical. In order to pursue with this plan, they need a strategy to strengthen the environment, policy and regulatory framework, human capital, green technology, financial instruments and others towards a more sustainable patterns of consumption and production. More alternatives of actions are needed for continuous improvement and ultimately improve the wellbeing and the better quality of life.

Computer-aided approaches help the decision makers reach their final decision. Any computer-based system supporting decision making is defined as a DSS Finlay (1989). Decision Support System (DSS) incorporate computer-based models of real life biophysical and economic systems. The goal of making a model-driven DSS accessible to non-technical specialists implies that the design and capabilities of the user interface are important to the success of the system (Power and Sharda, 2007). A model-driven DSS user interface provides capabilities for inputting values, for manipulating values and of equal importance, the user interface controls how the user views results and influences how the user understands results and hence influences choices. The structure of this paper will demonstrate the development in methodology section, presenting an output in analysis section and finally conclusion section.

2. Methodology

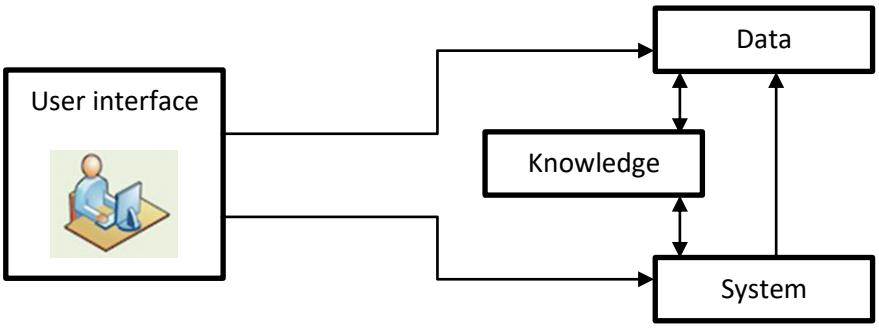
2.1. System Development Process

The prototype PMSP System development environment consists of XAMPP v3.2.2. The purpose of XAMPP software is to create and run a local web server for application testing and debugging. Next, the text editor that are used for programming is Sublime Text 3.0. Sublime Text 3.0 offers fast and robust coding experience. Sublime Text also have beautiful syntax highlighting which make it easier for programmer to distinguish between programming languages. It is also equipped with multiple plug-ins which are useful for coding purposes such as Sublime Linter, which act as error indicators for the coding. For system running and testing the web application, Mozilla Firefox Quantum v59.0.2 are chosen. Mozilla Firefox Quantum are stable and fast. It also supports modern web technologies and programming languages, which is helpful for running the application. Mozilla Firefox Quantum is also able to render the web page accurately. Furthermore, Mozilla Firefox Quantum also provides a reliable developer tools which is called Firefox Developer Tools. Firefox Developer Tools are used for examining, editing, and debug HTML, CSS, and JavaScript on the desktop and on mobile. The mark-up language that is used for developing the User Interface for the application are Hypertext Markup Language (HTML), a standardized system for tagging text files to achieve font, colour, graphic, and hyperlink effects on World Wide Web pages. Cascading Style Sheets (CSS) mark-up language is also used for the designing purpose. CSS is a style sheet language used for applying styling to the HTML document, such as setting the background colours and fonts.

The main programming language that are used for data processing and calculation is JavaScript. JavaScript is a scripting programming language that allows the implementation of complex things on web pages. JavaScript enables to create interactive web pages such as dynamically updating content, control multimedia and animated images. For the application development, multiple Frameworks and Plug-ins are used in the project to speed up and ease up the development. In designing the User Interface, Bootstrap Framework is used. Bootstrap is an open source toolkit for developing with HTML, CSS, and JavaScript. It provides extensive prebuilt components and also powerful plugins that are built on jQuery Javascript Framework. jQuery JavaScript framework is a fast, small and feature-rich JavaScript library. jQuery are used in this project development. It helps speed up JavaScript coding by providing many prebuilt programming functions and components.

The application uses Microsoft Excel worksheet as the main database. The xlsx Excel worksheet will store all the necessary data. Microsoft Office Excel 2016 are used for creating and managing Excel Worksheet, as a database to restore the data set. The application will open and read the content of the Excel worksheet using SheetJS JavaScript plugin. SheetJS plugin will help to read the content and parse the data into structured format for easier data manipulation with JavaScript. The data that have been read will be displayed on the User Interface. The application will receive the input from user, and perform the processing and calculation in real-time and interactively. Next, the application can generate Line and Bar Graphs using ChartJS JavaScript plugin. ChartJS is a plugin that provide an easy way to include animated and interactive graphs to web pages. Finally, user is able to export and save the graphs to PDF file format. The jsPDF is used for extracting the graphs and generate a PDF for user to download. The system architecture are summarized in Figure 2.

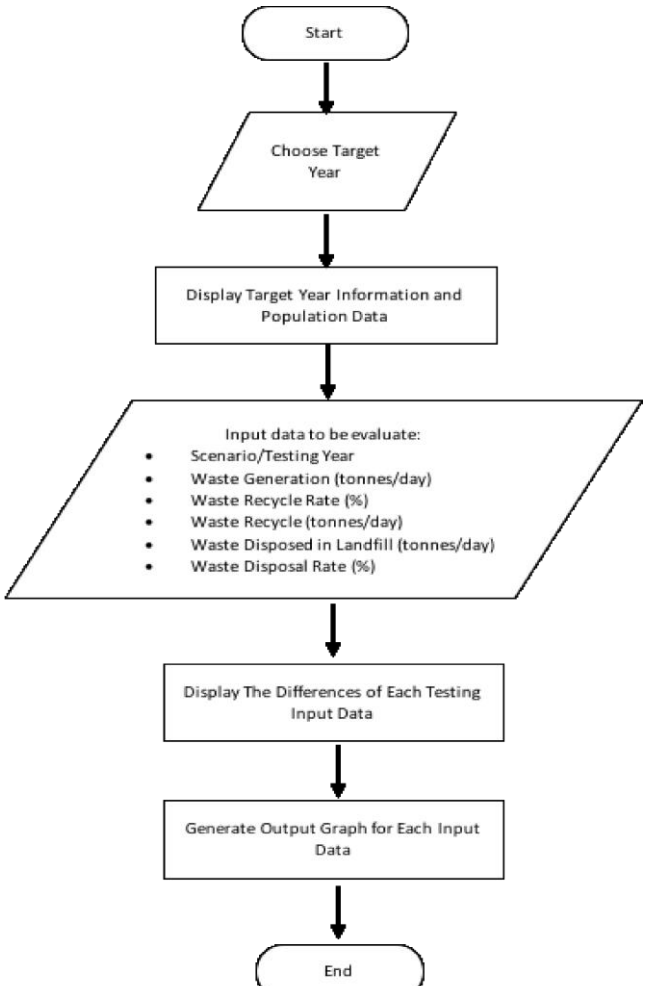
Figure-2. System architecture of prototype PMSP system



2.2. System Flow Chart and User Interface

Several discussions have been conducted with the Research Development Division of SWCorp (Solid Waste and Public Cleansing Management Corporation) for gathering all information and identification of key important elements towards the evaluation of the achievement of strategic planning. These elements play an important role in solid waste management process in order to monitor the efficiency of each strategy and policy plan. Thus, all the elements will be included in the development of prototype PMSP System. Figure 3 shows the process flow of the development of prototype PMSP system.

Figure- 3. The process flow of prototype PMSP system

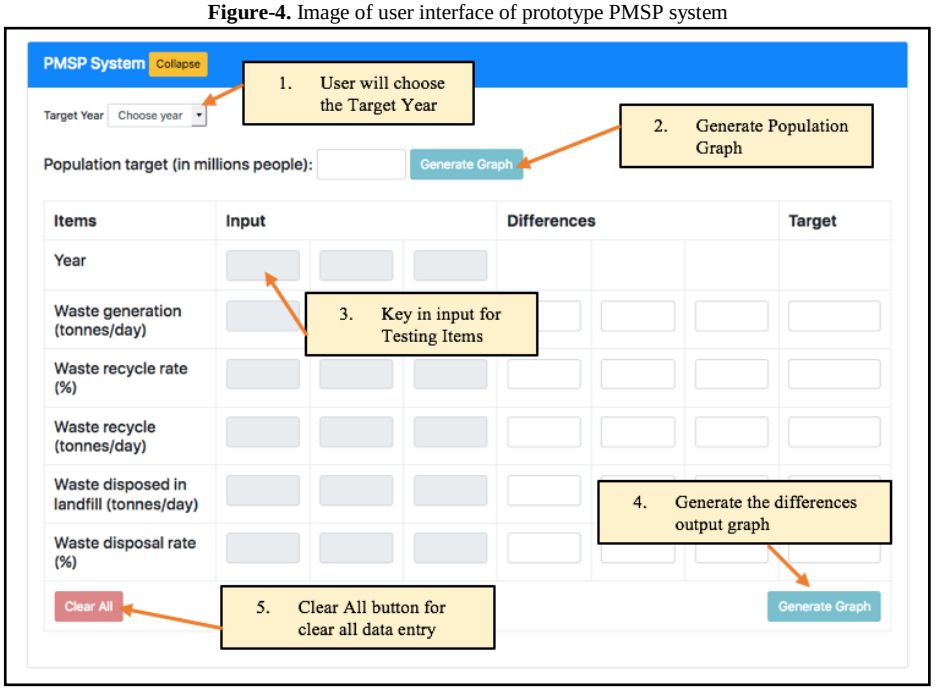


3. Results

3.1. User Interface of Prototype PMSP System

Figure 4 represent the user interface. First, the user of this system is required to choose the target year. Target year is consisting of target set by Solid Waste Corporation (SWCorp) on their strategic planning performance and currently set by year 2020. Second, the system will retrieve from dataset and display the information of target year and population. Third, the user is required to key in input data for: Scenario testing year; Waste generation quantity; Waste recycle rate; Waste recycle quantity; Waste disposed in landfill quantity and Waste disposal rate. Forth, the system automatically calculates the difference of achievement of testing year towards target year. Finally, the user can generate bar chart in order to present the output for each input of testing year. Flexibility is given to the user to conduct three scenario analyses for testing year. All input data can be deleted by clicking the clear all button.

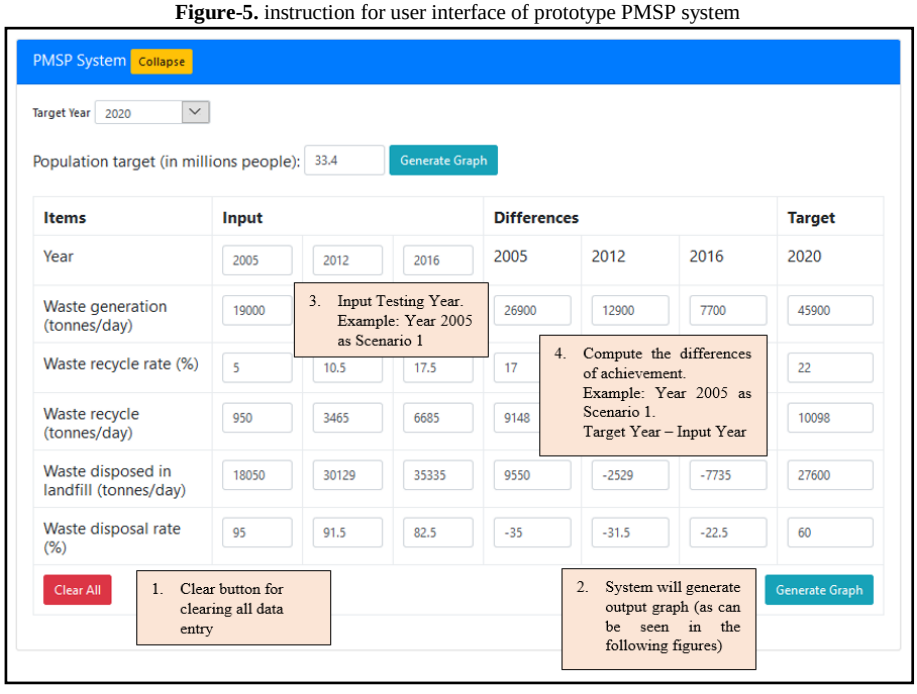
Figure-4. Image of user interface of prototype PMSP system



3.2. Manual Guideline for User

Figure 5 illustrates the procedure for user in order to key in the data entry. The user is explained on how to use the system accurately.

Figure-5. instruction for user interface of prototype PMSP system



3.3. Output of Prototype PMSP System

Figure-6. Population graph 1981-2020

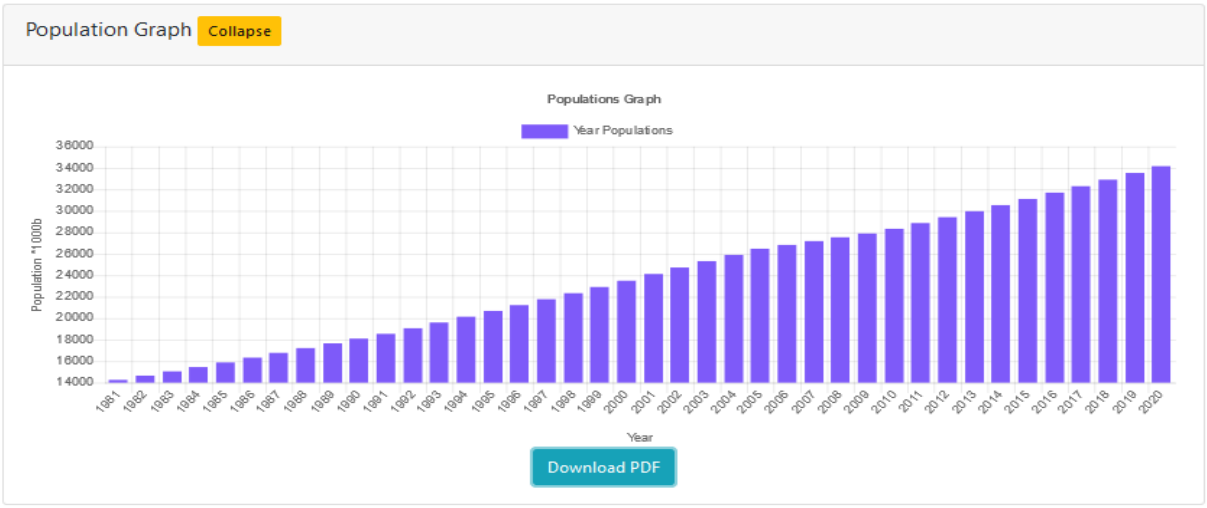


Figure-7. Waste generation (tonnes/day)

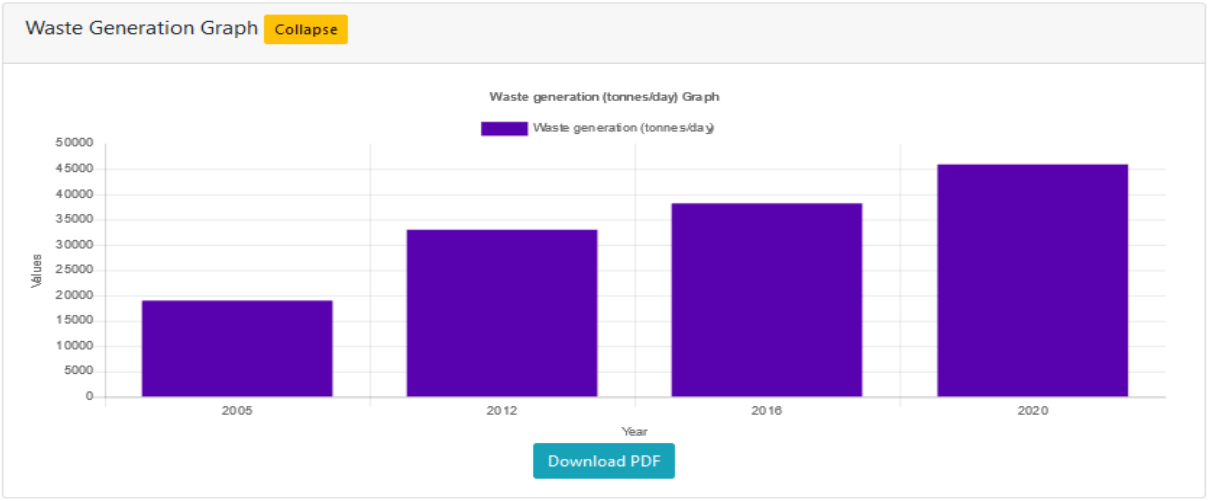


Figure-8. Waste recycle rate (%)

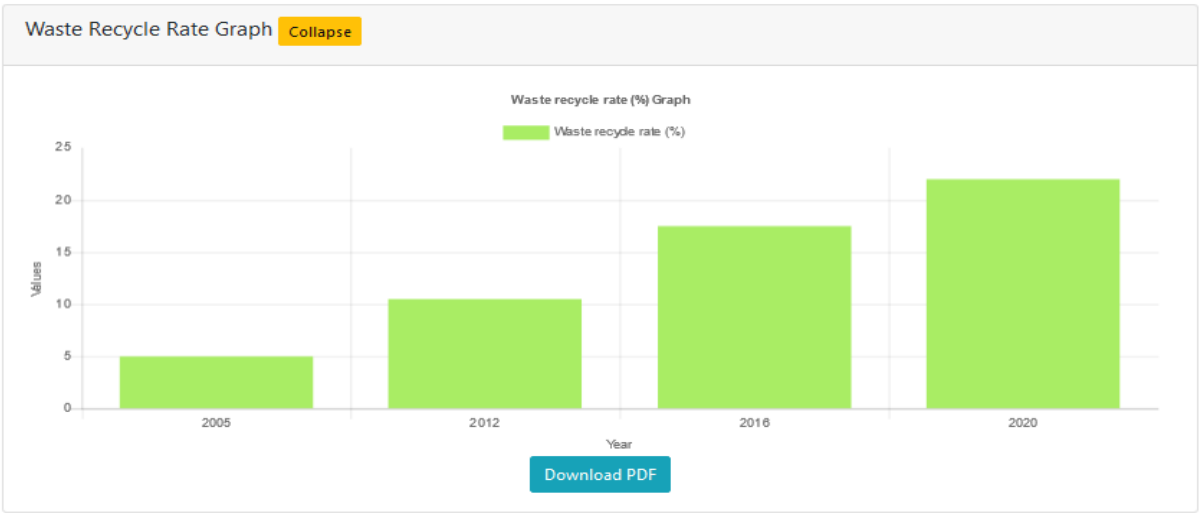
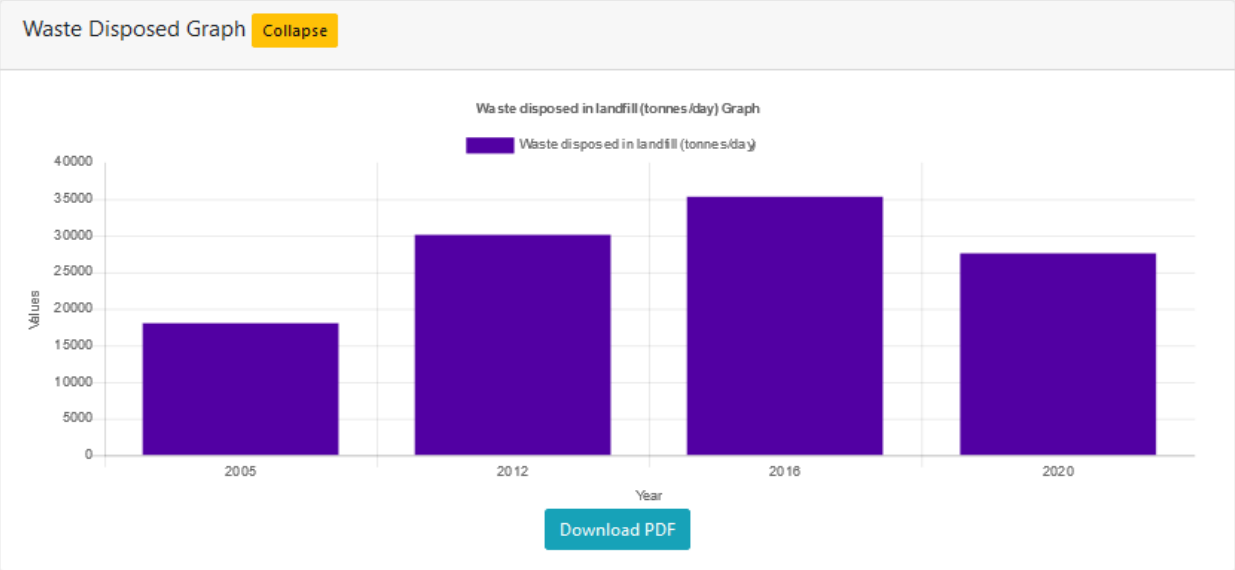


Figure-9. Waste disposal in landfill



Population in Malaysia from 1981 until 2020 as in Figure 6 shows an increasing trend annually. This trend which is an increment 2% approximately (Zainal *et al*., 2002). In year 2020, the population in Malaysia is predicted to be 33.34 (millions) people. This factor contribute to the waste generation quantity in Malaysia. Due to this scenario, the quantity of waste generation in 2012 (33000 tonnes/day) compared to 2016 (38200 tonnes/day) also increase approximately 14% as in Figure 7 (KPKT, 2017). This is particularly alarming, especially for the solid waste management which gives an urgent need by the management to monitor the development of strategic plans that are designed to achieve the desired level.

Figure 8 is an output generated from the input of testing year compared to the target year for recycle rate (%). The graph shows positive increment trend from 2005 (5%), 2012 (10.5%) and 2016 (17.5%) and it is expected to achieve a target of 22% by 2020. This recycle program in Malaysia is almost successfully implemented. However, this recycle program is still considered to get medium acceptance, especially from the public. In addition, this result is parallel with the outcome from (Zulkipli *et al*., 2018) that show the acceptance of solid waste management practice are still in medium level. Therefore, the awareness level on waste recycle needs an extreme enforcement from authorities for public acceptance.

Figure 9 illustrates the solid waste disposal rate at the landfill. It shows an upward trend where in 2005 (18050 tonnos/day), 2012 (30129 tonnes/day) and 2016 (35335 tonnes/day). This happens due to the conventional method of waste disposal, where the wastes are sent to landfill for final disposal. Recently, the landfill capacity are lacking and almost full. The waste management are trying to have a mitigation action on finding the new location for landfill. Hence, the authorities and waste management department need to look for green solution in managing the disposal process to ensure of a sustainable environment in the future and achieve the target of reduction to 27600 tonnes/day in 2020.

4. Conclusions

The critical problems in Malaysia with massive population rate, less quality of environment and improper waste management have made severe impacts on solid waste generation. The process of monitoring the success of strategic planning is important to ensure that every planned plan can be achieved and mitigation measures can be implemented immediately if there is a plan yet to be achieved. Therefore, the development of the prototype PMSP System may be considered as alternative ways to help operational level for monitoring their strategic planning achievement in an efficient way. The user is not required to have special skill in computer science. They can learn on how to use the system in a short time. The advantages of the developed prototype PMSP System are it is user friendly, does not require high technological skill and cost effective. In the future, perhaps the system can be implemented in a real scenario in order to test the efficiency of the system.

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