Preliminary Design Concept of Garbage Collecting Machine

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Abstract. Malaysia can only recycle about 1,150 tons of solid waste than 23,000 tons of solid waste disposed of every day. This amount is equivalent to 5% of the total solid waste disposed of. At the same time, 19% of waste is dumped into water drainages such as rivers, trench, and drains. This activity contributes to clogged drains, mosquito breeding, and the transmission of other diseases. Waste management is an important issue that is commonly discussed and highlighted in the media. The most common issue is how to efficiently and effectively collect garbage waste. The current method of collecting garbage is very time-consuming and requires many workforces. In addition, the existing machine is expensive, and its usage is limited to certain areas only. To save the energy of human resources and time, a new garbage collector design should be proposed. Usage of machines focused on the big flat area such as at a field and open area like parking lot area. This area is commonly used for significant events like a night market, expo, concert, or exhibition. Therefore, this concept design is intended to solve and surmount the stated problem by designing and developing the new design garbage collector machine. The concept design follows an essential design process that identifies needs, conceptual design, embodiment design, and detail design. This design can be developed for the expected result and proceed for proof-of-concept testing to test the functionality and capability.

1. Introduction

Since gaining independence in 1957, Malaysia has taken steps to become a developing country with extensive economic progress. The resulting economic development has impacted the rapid increase in population, township, and industry. In line with the increase in population, consumption of goods and disposal of solid waste increased in large numbers and amounts.

The disposal of solid waste, including scrap material, other unwanted surplus substances, or rejected products, is required by the authority to be disposed of as stated in Solid Waste and Public Cleansing Management Act 2007, which was enacted to regulate the management control of solid waste and public cleansing [1]. These exclude scheduled sewerage which means any liquid waste or wastewater as stated under the Environmental Quality Act 1974 (Act 127), or radioactive waste as defined in the Atomic Energy Licensing Act 1984.

Under the Solid Waste and Public Cleansing Management Act 2007, public cleansing management services are defined as cleaning solid waste, including that which is dumped illegally in places shared by everyone, such as public toilets, drainage, and non-private roads and public places. The clean-up also covers public hawker centers and markets that private parties do not run. In addition, cleaning works in beach areas, lawn mowing on public roads, and landscaping works are included in this service.
Every day the household in Peninsular Malaysia generate solid waste of about 37,890 metric tonnes. With 32.6 million, the per capita waste generation is about 1.7 kg/capita/day [2-3]. This figure had increased dramatically and drastically compared to 2005, where 19,000 metric tonnes of waste were generated per day, and during that time, capita waste generation was about 0.8 kg/capita/day. In the year 2020, 30,000 tonnes of solid waste per day was generated in Malaysia. For areas with high populations, the total production is expected to exceed 30,000 tonnes per day [4].

Table 1. Public solid waste generation in Malaysia

| YEAR | 2013   | 2014   | 2015   | 2016   |
|------|--------|--------|--------|--------|
| JAN  | 7,828  | 5,898  | 12,225 | 16,286 |
| FEB  | 9,842  | 5,531  | 14,507 | 20,428 |
| MAR  | 7,404  | 6,358  | 8,353  | 20,796 |
| APR  | 9,308  | 6,234  | 13,285 | 15,769 |
| MAY  | 9,185  | 5,336  | 13,249 | 16,197 |
| JUNE | 10,098 | 6,305  | 13,496 | 15,898 |
| JUL  | 8,360  | 6,742  | 15,037 | 16,913 |
| AUG  | 11,476 | 6,360  | 13,780 | 14,451 |
| SEPT | 9,475  | 6,667  | 12,971 | 17,181 |
| OCT  | 9,583  | 7,076  | 13,562 | 17,496 |
| NOV  | 9,802  | 6,725  | 14,692 | 15,063 |
| DEC  | 9,435  | 6,394  | 14,979 | 16,869 |
| TOTAL| 111,796| 75,627 | 160,136| 203,349|

Table 1 shows the generation of public solid waste in Malaysia from 2013 until 2016 [5]. It can be seen that the trend of generation increases year by year. Thus, appropriate action must be taken to control this situation. According to Zia & Devadas [6], solid waste production is identified from 3 primary sources: industrial, commercial, and domestic solid waste. Around the world, this trend of solid waste production is continuing to increase from time to time. Among the effective methods of controlling and curtailing solid waste generation is to ensure that the waste collection process runs efficiently. For this purpose, the use of technology is constructive. For more effective waste management, applying technological elements is one of the options. Therefore, for long-term solutions, the impact on risk, sustainability impact, environmental impact, and the impact of technology must be considered by Malaysia before using it. [7].

2. Literature review

2.1 Current existing design

Cleaning waste vehicles have been used widely since the 1940s in Europe, such as the United Kingdom and the United States. As a result, the products are in the world's leading position. Having been used and developed year after year, this machine has evolved with the application of current technology, which makes it more perfect and mature [8].

Meng and Sheng [9] developed the design of a small lawn garbage sweeper that uses two motors to operate the machine powered by the power supply. The front motor is used for the sweeping function and conveying mechanism. Whereas the rear motor use for wheel running. A controller board controls this machine. The machine sweeps the garbage and sucks the dust, transfers it through the conveyor, and moves the garbage into the bin, as shown in Figure 1.
Arun [10] designed and fabricated a garbage collector using solar power, as shown in Figure 2. This machine is designed and focused on using it in the beach area. The development combines three mechanical parts, which are conveyor, motor, and gear. Two direct currents (DC) motor is with different type use. One motor is the gear motor, and another one is the high-speed motor for the conveyor. To operate the machine, the solar system is used as the primary energy.

Brijesh [11] also developed and fabricated a waste collecting machine that combined the motor, conveyor, and gear mechanism to operate the machine, as shown in Figure 3. The feeder part consists of a roller with brushes and many steel plates attached to the axis. The battery is used as a primary electrical supply. The difference with the other concept is that this machine movement is a dual-mode control system. Thus, it can be controlled by remote or by mechanically.

Benchmarking is the practice of comparing an organization's performance or capacity, which can be measured in a variety of ways. It's also defined as a constant process of identifying and implementing best practices that lead to improved results. These existing items are all rubbish collectors and Table 2 summarizes the product investigations that have already been discussed.
Table 2. Product specification benchmarking of existing products

| Description                        | Design Concept 1 | Design Concept 1 | Design Concept 1 |
|------------------------------------|------------------|------------------|------------------|
| Existing design:                   |                  |                  |                  |
| Application: Open area and limited surface |                  | Beach area       |                  |
| Powered by: Power electrical supply |                  | Solar energy     | Battery energy   |
| Operated: Controller board         |                  | Mechanically     | Remote and mechanically |

3. Methodology
3.1 Conceptual design
Component decomposition analysis is a process flow or flow chart that shows two parts, namely the components used and the main components in the design. A detailed description of each item and part will be listed in this flow chart to facilitate the process. The primary component used has to be listed first to allow us to construct the component layout efficiently. Each of the components has to relate to each other. Figure 4 shows the flow chart of the designing process consists of problem identification and design selection.

Figure 4. Flowchart of the designing process
3.2 Product Configuration

The general shape, general measurement, and component specification were determined in configuration design. The actual measurement and measurement error were determined in parametric design. Components can be classified into three main parts: standard part, particular purpose part, and standard assembly [12]. Standard components are components that are typically widely produced with volumes reaching millions of units. The specifications for these components are also the same in manufacturing materials, weight, and component size.

Meanwhile, special-purpose components are components that are produced for a specific function only. The special-purpose components are usually subsidiary. Table 3 shows the list of standard parts.

| Components       | Quantity |
|------------------|----------|
| Sweeper          | 1        |
| Wheel            | 4        |
| Conveyor         | 1        |
| Shaft            | 3        |
| Gear             | 2        |
| Screw, bolt, nut | 30       |
| Frame            | 1        |
| Plywood          | 1        |
| Hinges           | 2        |
| Garbage bin      | 1        |

3.3 Concept Selection

By referring to process as shown in Figure 4, the selection of the concept will focus on four main criteria:

- It reduces the workforce to handle the machine. In addition, this machine is easy to be used because the machine is just operating by one person.
- Environmentally friendly, no motorize system because the rotation of wheels powers the mechanism of garbage transmission.
- Less maintenance with no motor and batteries used
- No specialized and complicated. Therefore, parts are easy to find in an open market.

4. Result and final model

4.1 Sketching and detail drawing by Sketchup 3D drawing

After the concept selection is complete, all of the selected concepts are merged to form a full structure. Figure 5 depicts a rough sketch of the proposed concept. Following that, a Sketchup 3D drawing is used to further detail the drawing, as illustrated in Figure 6.

Figure 5. The proposed concept is sketched out.
4.2 Model development

Once all criteria have been gathered and selected, product model creation can begin. A smaller model has been developed to demonstrate that the conceptual design is effective and proved. The design of the model that has been developed is shown in Figure 7.
4.3 The model functionality
The machines function by sweeping any rubbish and dumping them into the machines' collector box through a rotation conveyor. The sweeper and conveyor rotation design is powered by the rotation of the machine's wheel with some addition of gear mechanism. Figure 8 shows the overall concept of how the machine works.

Figure 7. Actual view of the model.

Figure 8. The functionality of the machine

5. Conclusion
The design concept and the model of the garbage collecting machine model was successfully designed using a fundamental mechanical component such as tires, shaft, gear, and conveyor system. By introducing the concept that is an environmentally friendly approach, maintenance costs can also be reduced. Furthermore, the mini size will help users bring from one location to another easier and save operation time. Based on the analysis, this garbage collection machine design has a simple structure and meets its function as a garbage collector.
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References
[1] Solid Waste and Public Cleansing Management Act 2007, Act 672 (2017)
[2] Suhaila Shahrul Annuar, Rakyat Malaysia hasil 37890 tan sisa setiap hari (2019, Jun 16), BH Online. Retrieved from https://www.bharian.com.my/berita/nasional/2019/06/574909/rakyat-malaysia-hasil-37890-tan-sisa-setiap-hari
[3] Anggaran Penduduk Semasa, Malaysia, 2018-2019. (2019, July 15), Retrieved from https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=VjC3dFd5cXhNYTZtbVhS0lJEpwcUz09
[4] Prof Dr Ahmad Ismail, Teknologi tinggi urus sampah jana ekonomi (2017, Mei 25), BH Online. Retrieved from https://www.bharian.com.my/taxonomy/term/61/2017/05/286262/teknologi-tinggi-urus-sampah-jana-ekonomi
[5] Berat Kutipan Sisa Pepejal Dilupus Bagi Sisa Domestik, Sisa Pukal Dan Sisa Pembersihan Awam - MAMPU. (2019, October 22). Retrieved from https://www.data.gov.my/data/ms_MY/dataset/berat-kutipan-sisa-pepejal-dilupus-bagi-sisa-domestik-sisa-pukal-dan-sisa-pembersihan-awam
[6] Zia, H., & Devadas, V. (2007). Municipal solid waste management in Kanpur, India: Obstacles and prospects. Management of Environmental Quality: An International Journal, 18(1), 89-108. doi:10.1108/14777830710717749
[7] Zainu, Z., & Songip, A. (2017). Policies, Challenges and Strategies for Municipal Waste Management in Malaysia. Journal of Science, Technology and Innovation Policy, 3(1). Retrieved from https://jostip.org/index.php/jostip/article/view/47/23
[8] R.Kidwell-Ross, An over view of sweeping equipment technology, (2001) Am. Sweeper Mag.03,14-17
[9] Meng, Chao-ying & Sheng, Ya-dong. (2019). Design of Small Lawn Garbage Sweeper. MATEC Web of Conferences. 256. 02017. 10.1051/matecconf/201925602017.
[10] A, Arun & P, Nagasankar & P, Amirthalingam & .E, Barath & G, Janarthanan & AS, Magesh. (2018). Design and Fabrication of Garbage Collector on the Beach Using Solar Power. International Journal of Engineering & Technology, 7(3.34), 394. doi:10.14414/ijet.v7i3.4.19331
[11] Brijesh K, Karthik, Adarsh S, Githin, Kevin Xavier, (2019) Design and Fabrication of Waste Collecting Machine, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 05 page 2092-2098
[12] Katimon, M. N., Hassan, M. F., Tuparman, M. H., & Hamid, M. H. A. (2019). Preliminary Design Concept of Automatic Kerisik Packaging Machine. Journal of Industry, Engineering, and Innovation, I(2) page 1-6
[13] Thomas, A. S., Hassan, M. F., Mahmood, S., and M. H. A. Hamid 2019 Development of Machine Paper Plate from Natural Fibres. Journal of Design for Sustainable and Environment, I(2).