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“Optimizing Innovation in Knowledge, Education and Design”

EXTENDED ABSTRACT



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Assalamualaikum warahmatullahi wabarakatuh,



First and foremost, I would like to express my gratitude to the organizing committee of i-Spike 2023 for their tremendous efforts in bringing this online competition a reality. I must extend my congratulations to the committee for successfully delivering on their promise to make i-Spike 2023 a meaningful event for academics worldwide.

The theme for this event, 'Optimizing Innovation in Knowledge, Education, and Design,' is both timely and highly relevant in today's world, especially at the tertiary level. Innovation plays a central role in our daily lives, offering new solutions for products, processes, and services. By adopting a strategic approach to 'Optimizing Innovation in Knowledge, Education, and Design,' we have the potential to enhance support for learners and educators, while also expanding opportunities for learner engagement, interactivity, and access to education.

I am awed by the magnitude and multitude of participants in this competition. I am also confident that all the innovations presented have provided valuable insights into the significance of innovative and advanced teaching materials in promoting sustainable development for the betterment of teaching and learning. Hopefully, this will mark the beginning of a long series of i-Spike events in the future.

It is also my hope that you find i-Spike 2023 to be an excellent platform for learning, sharing, and collaboration. Once again, I want to thank all the committee members of i-Spike 2023 for their hard work in making this event a reality. I would also like to extend my congratulations to all the winners, and I hope that each of you will successfully achieve your intended goals through your participation in this competition.

Professor Dr. Roshima Haji Said
RECTOR
UiTM KEDAH BRANCH



WELCOME MESSAGE (i-SPIKE 2023 CHAIR)



We are looking forward to welcoming you to the 3rd International Exhibition & Symposium on Productivity, Innovation, Knowledge, and Education 2023 (i-SPIKE 2023). Your presence here is a clear, crystal-clear testimony to the importance you place on the research and innovation arena. The theme of this year's Innovation is "*Optimizing Innovation in Knowledge, Education, & Design*". We believe that the presentations by the distinguished innovators will contribute immensely to a deeper understanding of the current issues in relation to the theme.

i-SPIKE 2023 offers a platform for nurturing the next generation of innovators and fostering cutting-edge innovations at the crossroads of collaboration, creativity, and enthusiasm. We enthusiastically welcome junior and young inventors from schools and universities, as well as local and foreign academicians and industry professionals, to showcase their innovative products and engage in knowledge sharing. All submissions have been rigorously evaluated by expert juries comprising professionals from both industry and academia.

On behalf of the conference organisers, I would like to extend our sincere thanks for your participation, and we hope you enjoy the event. A special note of appreciation goes out to all the committee members of i-SPIKE 2023; your dedication and hard work are greatly appreciated.

Dr. Junaida Ismail

Chair

3rd International Exhibition & Symposium Productivity, Innovation, Knowledge, and Education 2023 (i-SPIKE 2023)

SMART WASTE BINS

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ABSTRACT

The purpose of this study is to design and develop a smart waste bin that utilizes innovative technology to improve waste management practices. The study employed a design and development methodology to create a framework for the smart waste bin. To reduce reliance on traditional sources of energy, solar panels were added to offer sustainable power for its operations. To increase the capacity of the bin, improve waste collection efficiency, and lessen the need for frequent emptying, waste compaction technology was added. Furthermore, real-time trash level monitoring utilizes sensors and data analytic to enable accurate estimations of bin fill levels. This information can be utilized to optimize waste collection routes, leading to cost savings and reduced environmental impact. The smart waste bins come in different sizes, catering to the diverse needs of various environments and users. Additionally, the advertisement panels present an opportunity for organizations and municipalities to generate revenue by displaying relevant advertisements or public messaging. Moreover, the smart waste bin is designed

with a 3 bins system to segregate different categories of waste such as organic waste, reject and dry waste. Reject waste refers to non-biodegradable waste including diapers, sanitary pads, bulbs and e-waste. This kind of waste will finally end up in landfills. However, organic waste will be turning up into compost and dry waste is undergoing a recycling process. The smart waste bin is an innovative solution for waste management that can help reduce waste overflow, improve cleanliness, and reduce the frequency of waste collection. The real-time trash level monitoring feature allows for efficient waste collection and management, while the advertisement panels provide an opportunity for revenue generation and with 3 Bins System. The smart waste bin has practical implications for waste management practices in public spaces, such as parks, streets, and commercial areas. It can help reduce the workload of waste management personnel and improve the overall cleanliness of public spaces. A special and innovative alternative that combines several features to enhance waste management procedures is the smart waste bin. It is a useful addition to the current waste management infrastructure and can lessen waste overflow and boost waste collection efficiency all around.

Keywords: Smart Waste Bins, Waste Management, Technology Management, Innovation Management

INTRODUCTION

In recent years, there has been an increased focus on sustainable waste management, especially in urban areas where waste generation is at its peak. The waste management process is mostly defined by the waste management hierarchy. The hierarchy explains how to manage waste which includes different techniques like reduction, reuse, recycling and finally disposal of waste (Sushil, 1990). Elsaid and Aghezzaf (2015) described a waste management system as the coordination of all duties, practices and resources for creating a platform that manages waste and obeys the environmental rules. Traditional waste management methods such as open dumping and incineration have been associated with negative impacts on the environment and public health. Uncontrolled disposal causes major heavy metal pollution in the water, soil, and plants. Trash that is thrown without managing and not thrown into the bin properly can accumulate on beaches and within gyres as it travels through the world's rivers and oceans. This debris damages physical habitats, transmits chemical contaminants, endangered aquatic species, and impedes human usage of the river, marine, and coastal settings.

Based on the data from the Malaysian Investment Development Authority (MIDA, 2021) has stated that with rapidly expanding cities and a burgeoning population, emerging countries such as Malaysia have several issues in handling garbage properly. Malaysia generated 19,000 tonnes of garbage per day in 2005, with a 5% recycling rate. Despite a 17.5% increase in recycling, the amount surged to 38,000 tonnes per day thirteen years later in 2018. This is concerning because the rate has surpassed the Japan International Cooperation Agency (JICA) study's predicted rate of 30,000 tonnes per day in 2020. With limited landfill space and rising disposal prices, there is increased pressure and an urgent need to address the waste management issue and lessen the impact on the environment and the general well-being of the population.

To address these challenges, advanced technological solutions such as Smart Waste Bins have been developed. Smart waste bins are a new generation of waste management systems that use advanced technology to optimize waste collection and disposal. Smart Waste Bins are designed to maximize waste collection efficiency and minimize environmental impact. They leverage advanced technologies to help reduce the amount of waste that ends up in landfills. They are portable and can be placed in public spaces such as parks, streets, and commercial buildings. They are equipped with unique features such as solar panels for power,

waste compaction, real-time trash level monitoring, sizes and advertisement panels to generate additional advertising revenues. With the innovation of these smart waste bins hoping that this will help reduce the environmental impact of waste disposal, improve waste collection efficiency, and improve the general cleanliness and hygiene of public spaces. They are becoming more popular in cities and public locations around the world as governments and businesses strive to improve waste management and minimize their carbon impact.

WASTE MANAGEMENT

According to Wikipedia, the entire process of managing waste, from generation to disposal, is referred to as waste management or waste disposal. Collection, transportation, treatment, and disposal of waste are all included, along with monitoring and regulation. It also includes the legal and regulatory framework related to waste management, including recycling guidance, etc. Humans continuously produce waste to the environment. The waste management is important to be able to minimize the environmental impact. It is about the set of activities required to be able to make a proper treatment of waste, from its generation to elimination or reuse. This includes waste collection, transportation, handling of special hazardous materials, recycling of usable materials. Over time, waste management becomes very important for ecological and economic reasons. From the very beginning, when waste management was based on transport to remote places and using incineration as a method of destruction, we have gone through the process of recycling.

In addition, it has increased public awareness of waste generation, which affects the design and use of products to reduce waste generation. On the other hand, laws aimed at reducing waste generation, such as charging for plastic bags or planning to ban the use of plastic in Europe in 2021, have fundamentally changed waste management.

Important of Waste Management

What is most important is preventing the generation of waste and minimizing it when it occurs. Next, we will find materials that are reused and recycled to a greater extent to save materials, generate energy and compost. Finally, waste that is not recycled will be disposed of in the most hazardous manner.

Waste management through various phases:

- a. Gather at the point of generation, as our home.
- b. Transportation to the appropriate location for the next stage of processing.
- c. Process as much as possible in the factory ready for reuse.
- d. Final disposal of waste that cannot be reused in any way.

Traditionally, there are two main methods of waste treatment, and neither of these methods contribute to material reuse or energy generation. it's about:

- a. Landfill: In short, garbage is stored away from the population center. The risk of contaminating soil, aquifers, or untreated hazardous waste can have a significant impact.
- b. Garbage incineration: The oldest method of garbage disposal, its pollution emissions are thrown into the atmosphere.

THE EFFECTS OF UNCONTROLLED WASTE

Waste thrown carelessly and not properly managed such as plastic and food containers will clog drainage systems such as drains, ditches and rivers and become the cause of flash floods, especially in urban areas. The government also has to spend a lot of money on maintenance due to the effects of uncontrolled domestic waste disposal such as flash floods. Open dump sites also require high costs to redevelop, in addition to lowering property values in nearby areas. The opening of a new landfill is difficult due to competition with other infrastructure needs (housing and industry) due to the limited land factor. Most critically, greenhousegasses produced by decaying solid waste will rise to the atmospheric layer and trap heat, resulting in the greenhouse effect that contributes to global warming and climate change phenomena, prompting extreme weather reactions in the form of storms and typhoons.

In fact, water pollution due to the permeation of 'leachate' (percolated water) into underground water sources also occurs. Failure to manage this type of solid waste is sure to invite disaster and cause adverse effects on public safety and health as well as the environment. Solid waste management can reduce up to 20 percent of greenhouse gas production globally and it is one of the three main strategies identified by the government to reduce the country's carbon emissions. As a result, it is very important to reduce the generation of waste from its production at the source, which is at the community level. In thismatter, Japanese society can be used as an example. They think that taking care of the environment is important because it is a shared right in the community, so they do not throw garbage everywhere in order to take care of the environment which is a shared right. Japanesepeople usually carry a plastic bag with them when they leave the house to keep the garbage they produce outside. This waste will be taken home and disposed of when they get home or at work.

The community can play a role in managing solid waste in their respective homes, by inculcating the practice of recycling. It not only reduces the production of solid waste but also generates side income. The Solid Waste Management and Public Cleaning Policy can be one alternative to emphasize that waste is managed according to the waste management hierarchy in reducing waste generation based on the 3R concept of 'Reduce' , 'Reuse' and 'Recycle'. Therefore, education and awareness of all levels of society, regardless of the economic level and social conditions must always continue.

Finally, policies and laws in waste management need to be refined from time to time in order to remain relevant and effective, especially in relation to monitoring, enforcement and related penalties.

INNOVATION OF SMART WASTE BINS



Figure 1. Solar Panel - Up to 60w

Figure 1 illustrates the integration of solar panels into smart waste bins. It is a remarkable technological innovation in the world of waste management. The power system for the smart waste bin includes a solar panel that is mounted at the top of the bin. The solar panel collects sunlight and converts it into energy, which is then stored in a battery cube. Even if there is no sunlight, the battery cube will continue to function. Once fully charged, the power system can operate for up to 4 weeks, regardless of the weather conditions. The solar panel is protected by a Polycarbonate Shield, which is highly resistant to external influences. This ensures that the power system remains functional and protected from damage.



Figure 2. Waste Compaction

Figure 2 illustrates the waste compaction feature of Smart Waste Bins which it helps to minimize the amount of space waste takes up in the bin. This feature makes smart bins the perfect solution for areas with limited space. The compactor crushes waste, increasing the capacity of the bin, and allowing for more waste to be collected before the bin needs to be emptied. Compaction is one of the key features of the smart waste bin, which involves the use of a Smart Compaction Module. This module enables the bin to compress or compact the waste, allowing for increased storage capacity. Here's how the compaction process works:

- As trash is accumulated in the smart waste bin, a fill-level sensor continuously monitors the level of waste inside the bin.
- Once the fill-level sensor detects that the bin is reaching its full capacity, it automatically activates the compaction cycle.
- The compaction process is carried out using the X-Frame Compaction Module located within the cube laps of the bin. This module is designed to apply a force of up to 720 kgf (kilogram-force) for efficient waste compaction.

By compacting the waste, the smart waste bin effectively reduces the volume of the trash, creating additional space within the bin. This increase in internal capacity allows for a longer time between emptying cycles and ultimately leads to more efficient waste collection and disposal practices. The compaction feature not only helps optimize the use of the waste bin but also contributes to reducing transportation costs associated with frequent waste collection and minimizing the overall environmental impact.



Figure 3. Smart Waste Bins can Sense Hands



Figure 4. Smart Waste Bins can Detect Fire

Figure 3 and Figure 4 illustrate the safety aspects of the smart waste bins. Safety is a critical aspect of the smart waste bin design, aimed at ensuring the well-being of users. The bin incorporates several safety features to prevent accidents and respond effectively to emergencies.

- d. **Intelligence Safety Sensors:** The smart waste bin is equipped with intelligent safety sensors. These sensors continuously monitor the bin's environment and detect the presence of any person's hand during the compaction cycle. Upon detecting a hand, the sensors immediately halt the compaction cycle to prevent any potential injuries.
- e. **Fire Detection System:** The smart waste bin also includes a fire detection sensor. In the unfortunate event of a fire occurring inside the bin, the sensor detects the flames or the presence of heat and triggers an immediate emergency notification to the users. This early warning allows for quick action to be taken.
- f. **Fire Suppression Capability:** In addition to the emergency notification, the smart waste bin attempts to control the fire by utilizing its compaction functionality. By compacting the waste and reducing the oxygen supply to the fire, the bin aims to suppress the flames and limit their spread.
- g. **LED Indicator Lights:** The smart waste bin features LED indicator lights that provide real-time feedback on its status. These lights display the approximate fill level of the bin, allowing waste management personnel to determine when it needs to be emptied. Additionally, they convey the bin's operational ability, indicating whether it is functioning properly or requires attention.

By incorporating these safety features, the smart waste bin strives to create a secure environment for users. The immediate response to potential hand injuries during the compaction cycle, early detection and notification of fires, and efforts to suppress flames within the bin all contribute to enhanced safety measures. The LED indicator lights provide real-time information, aiding in efficient waste management operations and facilitating proactive maintenance when needed. Real-time trash level monitoring is a unique feature of Smart Waste Bins as it enables the monitoring of the waste level in real-time. This feature informs the waste management team when the bin needs emptying, reducing unnecessary trips to the bin and increasing efficiency.



Figure 5. Three different sizes of Smart Waste Bins

Figure 5 illustrates the three different sizes of smart waste bins. Smart waste bins come in different sizes to cater to different waste management needs. They can range from small bins for households to large bins for public spaces. The sizes focus more on 120L and 240L for the capacity of smart waste bins. These specific models are designed to be compatible with the commonly-used wheelie bins found in many regions across the globe. The benefit of this feature is that waste collectors can easily empty the bins into the 120L or 240L bins, making waste collection a convenient task. Additionally, these models are designed to handle waste of various weights, further enhancing their convenience and practicality.



Figure 6. Advertisement Panels

As shown in Figure 6, the advertisement panels are an additional feature that is added to a smart waste bin. These panels are designed to display advertisements and generate additional revenue for the owner of the waste bin. The LED backlight option ensures that the advertisements are visible even at night, making them more effective and increasing the chances of generating revenue. This feature is particularly useful for businesses that want to advertise their products or services in a high-traffic area. Besides, smart waste bins offer a unique opportunity for advertisers to promote their brand by displaying advertisements on the bin. Advertisements displayed on Smart Waste Bins increase the potential reach of the advertisement campaign as they can be viewed by a large number of people in public places.



Figure 7. 3 Bins system

Figure 7 illustrates the smart waste bin is designed with a 3 bins system to educate society on waste segregation into different categories such as organic waste, reject and dry waste. Reject waste refers to non-biodegradable waste including diapers, sanitary pads, bulbs and e-waste. This kind of waste will finally end up in landfills. However, organic waste will be turning up into compost and dry waste is undergoing a recycling process. This approach would be helpful to prolong lifespan of landfills, reduce the effect of greenhouse gasses and significantly impact on environment sustainability.

CONCLUSION

In conclusion, this innovation presents the design and development of a smart waste bin that utilizes innovative technology to improve waste management practices. The bin incorporates solar panels for sustainable power, waste compaction technology to increase capacity and efficiency, and real-time trash level monitoring for optimized waste collection routes. The smart waste bins come in different sizes and offer an opportunity for revenue generation through advertisement panels. The study concludes that the smart waste bin has practical implications for waste management practices in public spaces and is an innovative solution that can help reduce waste overflow, improve cleanliness, and reduce the frequency of waste collection.

The focus on sustainable waste management has increased in recent years, particularly in urban areas where waste generation is high. The waste management process is defined by the waste management hierarchy, which includes techniques like reduction, reuse, recycling, and disposal. Traditional waste management methods have negative impacts on the environment and public health. Malaysia faces challenges in handling garbage properly, with limited landfill space and rising disposal prices. To address these challenges, advanced technological solutions such as Smart Waste Bins have been developed. Smart Waste Bins use advanced technology to optimize waste collection and disposal, maximize waste collection efficiency, and minimize environmental impact. They are becoming more popular in cities and public locations around the world.

Waste management involves the entire process of managing waste from generation to disposal, including collection, transportation, treatment, and disposal, as well as monitoring and regulation. Improper waste disposal can lead to clogged drainage systems, flash floods, and high maintenance costs. It can also contribute to greenhouse gas production, water pollution, and adverse effects on public safety, health, and the environment. Solid waste management can

reduce up to 20% of greenhouse gas production globally, and the community can play a role in managing waste through recycling and reducing waste generation. Policies and laws in waste management need to be refined to remain relevant and effective.

Smart waste bins are a technological innovation in waste management that offer several features to optimize waste collection and disposal practices. These bins are powered by solar panels and incorporate waste compaction technology to increase storage capacity. They also include safety features such as intelligent safety sensors, fire detection systems, and LED indicator lights to ensure user safety and facilitate efficient waste management operations. Smart waste bins come in different sizes and can be used for various waste management needs. Additionally, they offer an opportunity for generating revenue through advertising panels. Overall, smart waste bins are a practical and convenient solution for waste management in public spaces.

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