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Municipal Solid Waste Management: Community Perspective on Sustainable Waste Management in Kota Kinabalu, Sabah

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Abstract: A clean and beautiful environment is desirable. However, solid waste management becomes a significant challenge for most countries globally, including Malaysia, when urbanization occurs. The main objective of this study is to investigate the best sustainable approach in managing municipal solid waste (MSW) and the current practices of managing MSW in Sabah. The technique used to reach the objectives of the study, data collection, was using a qualitative method to distribute survey questions to the community that lives in Kota Kinabalu city. This study finding shows that the awareness among the communities is still low, and lack of governmental efforts to improve the MSW management. Therefore, to continually improvising Malaysia's MSW management, each party should play its role. For future suggestions, Malaysia should consider using modern technology as a game-changer in waste management sustainability.

Keywords: MSW, MSW Management, Sustainability

1. Introduction

Generally, municipal solid waste (MSW) generation has risen considerably in urban areas due to growing population, urbanization, and improved lifestyles [1]. Every day, roughly 3.5 million tonnes of MSW are created in urban areas worldwide, while the generation of MSW was expected to reach 6.1

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million tons per day in the year 2025 [2]. Therefore, managing the environmental problem of MSW has become one of the most challenging challenges in Malaysia. Waste management is a complex process for inhabitants in developing nations since the consequences of improper waste management are severe, especially for the urban poor, who are more vulnerable to illness, accidents, and pollution [2]. In addition, due to the poor and inadequate solid waste management, problems such as loss of resourceful material and social cost occurred due to the social health impact, especially on rag pickers, community living on the dumpsite areas, and the general public [3]. Malaysian authorities from major cities seek solutions to overcome the municipal solid waste by conducting approaches such as landfill use, which eventually has become unsustainable due to the country's speedy development and diminution of landfill spaces in Malaysia [4]. In Malaysia, 89% of the collected MSW are disposed into open landfills [5]. This study aimed to investigate the best sustainable approach in managing municipal solid waste in Sabah.

2. Literature Review

2.1 Study Area

Sabah is one of the 13 states in Malaysia, and it is known as the second-largest state in the country. Sabah is in the Northern region of Borneo Island. It is mainly cover with mountainous forest, and Mount Kinabalu is one of their pride of joy. Also, more than half of the state is protected by the rainforest between the national parks and forest reserves. There is also an abundance of beautiful uninhabited islands and postcard-perfect beaches. Sabah population comprises 33 indigenous groups that communicate in over 50 languages and 80 ethnic dialects. However, the largest group of ethnicities in Sabah is the Kadazan Dusun ethnic as it makes up almost 30% of the population. There are approximately 24 administrative units in Sabah, with Kota Kinabalu as the state capital and two municipal councils, Sandakan and Tawau. Also, Sabah has 20 district councils and one town board [6].

2.2 Municipal Solid Waste in Sabah

Municipal solid waste (MSW) is widely known as the concept of rubbish, garbage, or trash produced by human everyday human activities. There is plenty of definition and perspective of MSW depending on how people describe it. MSW is any non-hazardous solid waste from a variety of home, commercial, and industrial sources. Municipal solid waste (MSW) is a term that refers to the waste generated by a municipality [7]. Most of this solid waste is produced without segregation to be either harmful or harmless [8]. Anthropologists MSW is defined as factual evidence of culture "what people have thrown and owned [9]", and according to ecologists, they claim that there is no waste in nature [10]. Generally, any waste from commercial and households is considered municipal solid waste. It is highly heterogeneous and relies on living conditions, geographical locations, cultural habits of individuals, housing, season, and composition [3]. Even though many different MSW understandings hold the same outcomes, it disadvantages the environment and society.

The rise in the world's population and the industrialization of more cities make it complex to handle the waste generated by city residents. The problem is due to the rising amount of waste from high material usage and changing waste and waste characteristics uncertainty concerning unregulated dumping and landfills that leak [9]. This rising issue on MSW has become a concern to the whole country. It has resulted in more problems in managing the waste produced, related to the cost of disposal, environmental health issues, limited space in the landfill, changes in legislation, political climate, and society's attitude. Hence, controls are becoming stricter overtimes. MSW in Sabah is under the city or district council control based on the Local Government Ordinance 1961 and is responsible for collecting treatment and disposal of solid waste in the city [11]. In 1976, the municipal council enacted Municipal Council (Anti-Litter) By-Laws, which allows the maximum compound is RM100, whereas the lowest compound is RM10-RM5. The enactment is accepted to create awareness for proper disposal and proper manner of waste. To simplify, people who pollute will be punished by By-laws [12]. The Malaysia Government through the Department of Environment (DOE) vision formulation, contributes to the nation-building through conservation and restoration efforts, pollution prevention and control, and the protection and promotion of the wise use of natural resources for sustainable

development for present and future generations to achieve a better level of health, safety, and quality of life. Besides, the DOE has also implemented a strategy on pollution control and prevention implemented through the Environmental Quality Act,1974 [13].

2.3 Municipal Solid Waste Composition and Generation

MSW is a complex and multi phases mixture because it has heterogeneous nature. For many developing countries globally, solid waste management is one of the most daunting and everlasting problems [14]. It represents that the determination of composition is challenging. Therefore, it is crucial to know the MSW quantity and characteristics to settle on a management system's right choice. The large volume of urban solid waste is a significant ecological threat and a primary social concern [8].

Nevertheless, the data for characteristics and quantity of MSW is often taken through the waste collected and disposed of in the landfill. Therefore, the data for Malaysian MSW compared to the European countries are very limited and incomplete. Moreover, the generation and composition of the waste are often changing as it is affected by the geographical location, urbanization including the cultural habits of individuals, type of housing, and the seasons. The composition of MSW is approximately 40-60% of urban solid waste that includes materials that can be recovered, including food waste, paper, plastics, glass, ferrous aluminium, and metal [15]. According to the Ministry of Housing and Local government, the estimated value of MSW for 2010 to 2013 is 0.70 kg/day/capita [16]. The number of wastes produced was 1.3 million. In 2019, the total generation of solid waste per capita was estimated at 0.9 Kg/person/day, and per capita annual weight reached about 292 kg [15]. Therefore, it indicated that the number of entire generations of waste is changing each year.

2.4 Current Practices of MSW Management in Sabah

Solid waste management is known as how resources are being used and the end life of the materials deposition in the waste stream. Last year, Malaysians discarded up to around 33 000 metric tons of garbage daily, resulting in approximately 1.2 billion government spending on rubbish collection [17]. During the year 2020, it is expected to generate an amount of 49 670 metric tons of waste per day by the country [18]. Solid waste management is becoming a significant environmental and public health issue in urban areas as urbanization occurs. According to Malaysia's new Act, solid waste management (SWM) in Malaysia requires intervention from various government departments from federal to state and down to local authorities [4]. Therefore, the local authorities will have some limitations to the delegation of authority from the Federal Government. However, the local authorities will be directly involved with the MSW [4]. Municipal Solid Waste Management (MSWM) can harm the environment or ecosystem without careful management through effective strategies and better technology applications. Therefore, it is essential to have proper waste management to handle the large production of MSW. However, in Malaysia and Sabah, the MSW management has mainly focused on collecting and storage, disposal and treatment, and MSW.

Solid waste collection methods have generally been carried out daily, especially in the city centre, commercial areas such as shopping centres, and public places. The collection methods in residential areas are usually done three times a week, while street collection methods are standard [6]. The most flexible and suitable type of collection system used in the residential or commercial areas is the stationary container system (SCS), where it can be easily accessible by road but if the road is not accessible, then hauled container system (HCS) will be used [6]. However, the collection system usually only focused on the urban area, mainly a developed area. Residents in non-rated areas and informal settlements are not covered by formal waste collection services and resort to open burning and open dumping in the nearby open spaces and dumping waste in the river and the sea.

Landfilling is commonly accepted as an effective incineration process for waste disposal. However, it only decreases waste and contains residuals and gaseous contaminants that require ultimate removal [19]. The landfills in Malaysia are under the jurisdiction of the Ministry of Housing and Local Government. The majority of Malaysia's landfills are inappropriate and in poor condition [15]; hence, the government has been trying to upgrade the disposal sites by setting up four stages of improvement to fulfil the Action Plan 1988 [20]. In Sabah, the existing sanitary landfill (level IV) is the Kayu Madang

landfill located in Telipok and has been operating since 2007. It is expected to be completed in the year 2018. Kayu Madang landfill has approximately 111 acres, and 11 hectares are reserved for the disposal of waste. It can accommodate up to 1.5 million tonnes of waste with a preliminary expected life of 12.5 years [12]. In 2019, through the Ministry of Housing and Local Government, the Federal Government had allocated RM130 million. The allocation was used to enhance and strengthen solid waste management for three landfill projects in Sabah. The new regional landfill is in Tawau, Beaufort, and enhances the existing landfill in Kayu Madang Telipok. Hence, the massive amount of MSW generated by the municipal activities and the need for new and enhanced landfills are crucial as the Kayu Madang landfill has reached its maximum capacity [16]. However, apart from the Kayu Madang landfill, some private solid waste disposal sites, such as disposal sites at Sandakan and Lahad Datu, are privatized by Alam Motivasi Sdn. Bhd and by Sharijadi Sdn Bhd. In Sabah, there are still 19 disposal sites operating [16].

Since the landfill has been the primary disposal method in Sabah, a landfill can typically undergo environmental and chemical treatment. Physical changes are caused by the soil matrix degradation process of solid waste refuse after the landfilling has been completed [19]. Liquid percolates through the solid waste matrix and directly influences the quantity and consistency of the leachate with rainwater's biochemical, chemical, and physical reactions within the solid waste. Besides, the quality and quantity of leachate are also affected by landfill age, precipitation, the difference in weather, type of waste, and composition[19]. Commonly, the design and construction of a landfill will include treatment for hazardous pollutants discharge in the leachate, where the leachate is channelled through a pipe and eventually to the sewer and released to the sea[19]. On the other hand, some landfill leachate treatments also have a separate system to treat the leachate simultaneously where the leachate pipes are linked to the domestic sewage pipe.

3. Study Methodology

The method that was used in this study was through the distribution of the questionnaire. Data collection included the populations, current practices of MSW, and the management of the system of waste. The data collection of this research was conducted in Kota Kinabalu, Sabah. Before the primary survey, a pilot study was carried out to test the experimental method and the questionnaire's validity before beginning the primary research, to improve the results' reliability, and check for errors and the difficulty level of the questions mentioned in the questionnaire. During the pilot test study in this research, there were three (3) steps carried out. For the first step, the questionnaires were constructed and checked for their suitability with the research objectives. The second step was to distribute the questionnaires to several local people in Sabah according to the recommended sample size for the pre-test questionnaire, which was 30 participants [21]. The questionnaire consists of four (4) parts and the language used in English. Therefore, using the English language in the study questionnaires was appropriate as it provides a better understanding for local and non-local people staying in the Kota Kinabalu area. The method used to generate the question was Google Forms. The distribution of a questionnaire to targeted respondents was done through social media applications such as WhatsApp, Facebook, and emails.

The targeted respondents in this study consist of 384 respondents since the latest population of Kota Kinabalu city were 550,000 in 2020 [22]. The methodology of data analysis in this research was by using descriptive statistical analysis. For parts A, B, and C, the collected data from Google Form questionnaires were tabulated into graphs, tables, and pie charts to show the data's distribution. Then, to better visualize the data, the data were analyzed using Microsoft Excel software to cover the essential function of statistical functions, including frequencies and cross-tabulation of data. In Part D, the questions and answer data from the open-ended questions were typed into Microsoft Word. The data was then analyzed by labelling or highlighting relevant words, phrases, or sentences that match the question's theme. From the highlighted terms and sentences, the data were used to verify the objectives of the research. The method used to analyze the open-ended questions was by using thematic analysis.

4. Results and Discussion

4.1 Multiple Choice Question

Part A: Demographic Information

The first part of the questionnaire as Part A, shows the general demographic information of respondents shown in Table 4.1 below. There were 384 respondents in this study, consisting of 52% of females and 48%. Most of the respondents came from 21 to 25 years old, which is 45% and followed by 26 to 30 years old. In terms of ethnicity, 30% of the respondents are Dusun, followed by Kadazan at 29%. The ethnicity of Sino Kadazan, Chinese, Malay, Indian and other made up 17%,7%, 1%, and 9% respectively of the total respondent. In addition, a few questions were asked regarding the background information of the respondents were included. Most of the respondents, around 73%, have a higher education level (IPTA/IPTS), followed by respondents with a secondary education level of 15%. Among the respondents, 27% lived in other areas in Kota Kinabalu, followed by Menggatal and Sepanggar at 11% and 14%, respectively. The private house is the typical type of respondent's residential area at 38%, followed by terrace house at 23%. The other residential areas that make up the total respondents were apartments, condominiums, and flat at 16%, 14%, and 10%.

Part B: Respondent Awareness toward MSW

The second part of the questionnaire was denoted as Part B, which included questions to know the respondents' knowledge regarding MSW. About two-thirds of the respondents know about MSW, 69%, followed by 17% of respondents who do not know, and 14% answered. Exposure of MSW mostly came from social media, which was 32% and followed by online articles 21%. At the same time, other sources such as television, newspaper, and school have less than 20% and followed with respondents who are not aware and unsure at 19% 14% respectively.

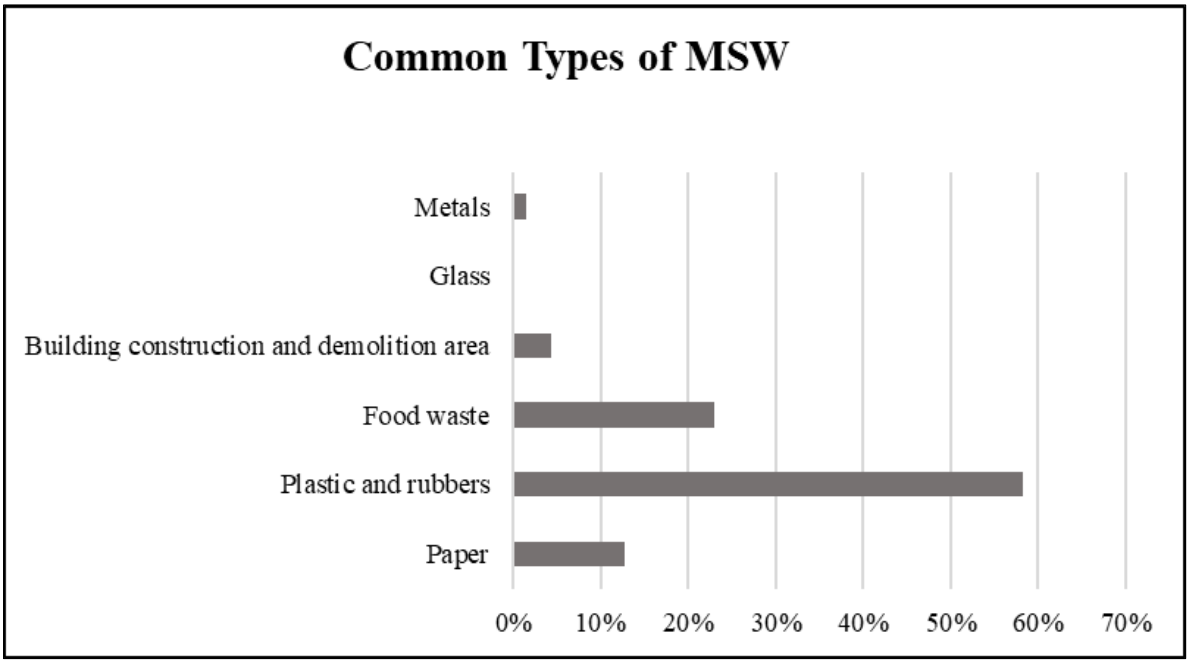

Figure 1: Common Type of MSW

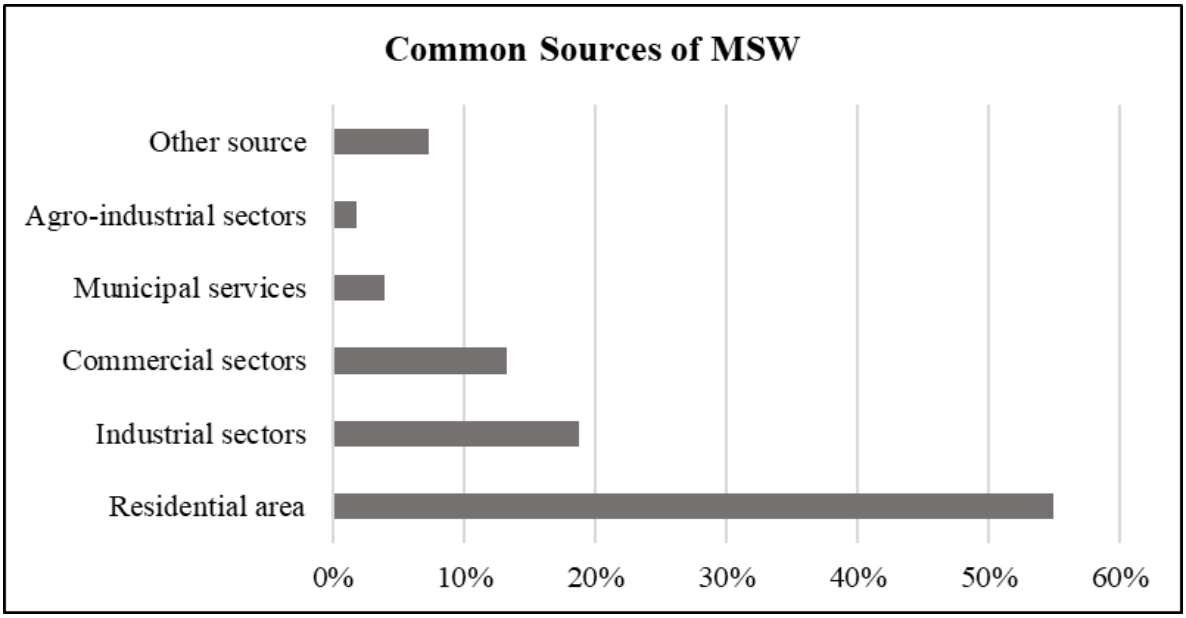

Figure 2: Common source of MSW

From the data in Figures 1 and 2 above, plastic and rubber waste the most common waste seen in a residential area. Plastic is known as the world's most significant health and environmental concern. It contributes as one of the third globally high waste sources, with plastic waste growing with population and per capita consumption. Since 2017, Malaysia has been recognized as one of the largest plastic waste importers globally [23]. Like the rest of the developing countries in Southeast Asia, Malaysia lacks insufficient waste management systems to deal with the volume of plastic waste generated, becoming a significant problem [24]. For the participation in the campaigns that related to waste management, it is very disappointing that half of the respondents at 59%, answered 'no' indicating that they had never joined any waste management campaign before, whereas for the respondent who answered 'yes' was only 31% followed by 9% of 'maybe' that make the total of the respondents. The government has launched several recycling campaigns in the 2000s to involve non-governmental organizations (NGO) and community groups and launch an extensive public education and publicity campaign. Unfortunately, the campaign received only a lukewarm response from the public [25].

The same thing happened to a recycling campaign launched in Penang in 2001 that aimed to encourage Penang residents to recycle at least 1% of their daily waste. Sadly, the movement lacked luck as it did not positively impact the waste management problem [26]. Moreover, environmental awareness among the public is generally still inadequate and has relatively weak and poor professionalism in handling solid waste management [26]. Therefore, the practitioners' skills and knowledge must be improved to launch solid waste planning management in the future successfully.

Part C: Current Practices of MSW Management

In this section, the respondents were asked about their current practices in managing the MSW daily. The first question was to know if their area of staying provides any municipal solid waste management services. It turned out that most of the respondents answered 'yes, which was 62%, followed by respondents who answered 'no' at 28% and respondents that were not sure if their place of staying provide the collection services or not at 9%. Since Kota Kinabalu is a city centre, it is relevant that most of the area is provided with solid waste collection. In Malaysia, only 66% of the population in the rural area is covered for waste collection, whereas the other areas that are not covered are more prone to waste dumping on streets and drains [26]. This practice of waste dumping into open areas brings severe environmental and social threats such as flooding and breeding of disease-carrying

animals. Another question was also asked to know whether their residential area provides any 3R bins to reduce, reuse, and recycle. The result showed that most respondents, 70%, have no 3R bin provided in their area. The respondents that answered 'yes' were only 23% and 'maybe' at 8%.

Providing 3R bins is one of the ways to encourage people to participate in recycling programs. Solid Waste Management (SWM) includes waste separation and segregation at the household level, known as the most economical and efficient way. Waste segregation guarantees the safety of waste materials and increases their ability to be recycled, which is vital for long-term solid waste management. Thus, with the provided 3R bins in the residential area or populated area, it can help in reducing the waste such waste in household. In addition, waste in-household can be separated by composting food waste into the composter, and for other waste, it can be recycled by using the separation method [27].

The current disposal method practiced by most (73%) of the respondents is using garbage truck collection, whereas for burning and using waste pits at home area is at 17% and 10%, respectively. It is relevant that most of the respondents answered that they use garbage truck collection because most of them lived nearby the city centre, which is Kota Kinabalu City. However, waste collection remains a significant issue, as there are still areas where local authorities are either unable to reach or unable to offer services to all residents under their jurisdiction [27]. Waste separation is the most crucial component in managing waste recycling and improving the quality of recyclables, reducing MSW, and optimizing incineration. However, the finding shows that half of the respondents, approximately 51%, do not practice waste separation before disposal. It happens because there is a lack of knowledge and expertise in recycling on the part of authorities that made the programs held for the community ineffective. Hence, the community gained a low level of knowledge regarding waste management, making it difficult to reach the main goals in environmental protection [28].

Although 90% of the respondents answered that they knew about 3R knowledge, there is still a lack of 3R practice in the community. The respondents who responded 'Always' to a question asked about how often they practice 3R was only 13%, whereas 'Often' at 12%. This low percentage shows that most of the community in Kota Kinabalu Sabah have low exposure to the importance of practicing the 3R concept. Most of them responded that they only practice 3R sometimes, which is at 42%. Whereas 'Rarely' and 'Never' are respectively at 28% and 5%. Composting practice was also part of the questionnaire as Malaysian produced an amount of food waste which is at around 50% to 60% of the waste in landfills and rose a significant concern on the groundwater contamination and potential release of toxic and gases [29]. 33% of the respondents had answered for 'Rarely' and 'Sometimes' at 30%. It shows that mostly the communities in Kota Kinabalu, Sabah, lack exposure to food waste composting. The only respondents who give 'Always' and 'Often' feedback is at 7% and 8% respectively and 21% for 'Never,' making up the 384 respondents.

However, in Malaysia, there is no comprehensive framework specifically for food waste management. Malaysia should consider adopting good models of food waste management from other countries such as Japan, where the government establishes a food waste law that requires food waste emitters to recycle their food into valuable products such as compost [30]. The local authorities should also encourage the community to practice composting by demonstrating basic techniques and information. The last question of this part was to ask the respondents whether they are affected or not by the MSW management in their area, and the result was that 63% of them answered 'Yes' to indicate that they were involved, and 24% comes from respondents who were not affected. Respondents who were unsure whether they were affected or not answered 14% of 'Maybe.' With the number of affected respondents, most probably the waste management is in a poor state.

Part C was ended by gathering a percentage of people to know the best method they would prefer to manage MSW. The results show that most respondents, at 65%, answered that 3R (Reuse, Reduce, Recycle) is the best method to handle the MSW, followed by landfilling with treatment at 23% and incineration at 11%. Surprisingly, there are still small proportions of respondents who chose to manage

waste using landfilling without treatment, which is at 1%, making up the whole number of responses. It is suggested that the 3Rs principle aids in improving waste management systems and reducing the human ecological footprint [31]. 3Rs helps enhance economic activity and reduces the environmental consequences of garbage, such as smelly odour from rotten food waste. In addition, it minimizes the loss of resources and extends the landfill's operational lifespan.

Part D: Importance of Sustainable Waste Management

In this part, the question asked were on the Likert scale. In terms of the importance of practicing 3R for sustainable waste management, most of the respondents voted for 'strongly agree,' and the least voted was 'disagree,' which was at 65% and 1%, respectively. The responses show that most respondents acknowledge the importance of 3R practice to have sustainable waste management. Regarding the agreement of satisfactory level of waste management in their area, most respondents responded 'neutral,' at 39%. It shows that 148 respondents feel undecided, stating that they are not sure whether solid waste management in their place is satisfactory. Whereas 28% of the respondents voted for 'agree,' indicating that management in their area is adequate, only a few voted for 'strongly disagree,' which is at 6%. The respondents were also asked about the condition of pollution level in their place of staying whether they agree or not that the area is satisfactory. The most voted level of agreement is 'neutral.' It is the most voted; it once again shows that they neither agree nor disagree with the statement. However, 30% of them voted for 'agree' that their stay is satisfactory, indicating that the area has only a little pollution, and only 6% of respondents voted for 'strongly agree.' In terms of health issues, most respondents voted 'agree' and strongly disagree' option that inefficient waste management can lead to health problem issues at 45% and 44%, respectively. Thus, the health issue has become a severe waste management problem, especially in the central city. Whereas option 'disagree' was moderately voted, which was at 1% of the total respondents.

Because of its technological feasibility, ease of operation, and low supervision requirements, landfilling is the most extensively used and preferred technique of solid waste disposal [19]. According to the Malaysian National Solid Waste Management Department, there are 296 disposal sites in Malaysia, 166 of the landfills are actively operational, and 130 have been closed [32]. Pollution of natural resources and environmental problems such as health hazards and contamination of surface groundwater are the most common causes of the landfills problem [33]. When water filters downward through a landfill, it produced leachate. As a result, it picks up dissolved contaminants from decomposing garbage, contaminating groundwater and surface water, both sources of drinking water [34], which eventually causes health problems to the community and flora and fauna.

In the efforts to manage the waste, 49% of the respondents voted for 'strongly agree' and 41% on 'agree' response that strengthening the law can help to succeed in sustainable waste management, whereas only a tiny percentage of respondents that responded, 'strongly disagree' and 'disagree' which was 2% and 0% respectively. Meek and shallow regulations and guidelines are among Malaysia's impending implementation of recycling programs [4]. Examples of implementation of rules and policies can be taken from other countries such as Japan and Germany. For example, recycling is done through shop trade-in, barter system activities, community-based systems, and private and public methods in Japan. While in Germany, they have laws regarding the deposit system, waste disposal fee, and the amount of trash to be used in production [25]. According to the Minister of Housing and Local Government, the overall campaigns launched in the early 2000s were a failure, as only 2% of waste was recycled after more than two years of recycling campaigns. However, filling the Petronas Twin Tower with waste takes only nine and a half days [35].

Developing a sustainable market for products made from municipal waste is one of the options most of the respondents agreed on to encourage the community to recycle. They opted to 'strongly agree' with the statement 48 percent of the time and 'agree' with the statement 40 percent of the time. Only 9% of respondents said they are "neutral," followed by 2% and 0% for "strongly disagree" and

"disagree," which make up the respondent's total. Developing a sustainable market can reduce waste productions and improve community awareness of recycling programs. Unfortunately, there is still a low number of the recycling industry in Malaysia, although Malaysian attitude shows a positive sign; hence, an enhancement must be done to the industry. An example of a sustainable market for products can be taken from Sweden. In terms of sustainability, 53% responded that they were 'strongly agree' that sustainability is vital to maintain the quality of health and environment of a community, whereas 36% responded for 'agree' and 2% for 'disagree.' For long-term success, sustainability is a vital component of sustainable solid waste management. As a result, governments are increasingly establishing legislation to influence waste management practices. A slew of new initiatives has sprung up in countries worldwide in recent years [36].

4.2 Open Ended Question

The questionnaires conclude with an open-ended question asking if respondents have any suggestions for improving Sabah's waste management. Thematic Analysis was the method employed in this section. According to the general study results, most respondents believe that the community is unaware of 3R. (Reuse, Reuse, and Recycle). As a result, it is recommended that the competent authorities organize more 3R program campaigns, particularly in rural regions, which are more prone to open burning and unlawful dumping.

Furthermore, some of the responders suggest recycling centres should have a fee structure to encourage people to recycle. The necessity to upgrade the facilities, according to the respondents, is equally critical. Many of the recommendations are to expand the number of garbage cans and rubbish collection in residential areas, particularly in rural areas. This demonstrates that, although Kota Kinabalu is a large city, there are still areas where the garbage collection system is not in place. The collecting system should be improved by altering the collection frequency. Few respondents believe the existing collection method is effective because trash left for an extended period rots, particularly food waste, and eventually emits a terrible stench in residential areas. Still, some respondents proposed that the government enhance the current waste management technologies. Instead of building a new landfill, the government should seek other options. The respondent suggests that Sabah follows the lead of other states and nations in terms of waste management. One recommendation was to provide a start-up service application service to collect waste through an application in the mobile phone such as the 'Trash4Cash' application, which has been in some of the states in Peninsula Malaysia. 'Trash4Cash' is a mobile application that collects recyclable waste from your homes in exchange for few ringgits. One of the recommendations for improving the quality of waste management is to enhance the law. Additionally, stringent waste management standards should be implemented regularly to improve people's attitudes and mindsets.

The government should impose strict legal action on those who disobey the rules, such as giving them penalties, providing more awareness signboards, and Closed-Circuit Television (CCTV) to remind and monitor people how they throw their waste in public areas. Good communication, understanding, and cooperation between the federal and local authorities regarding solid waste management policies and legislation are required to have efficient and effective solutions to MSW management. [5]. Finally, most respondents proposed that education be used to improve waste management in Sabah. Waste management and 3R awareness should be taught at a young age to motivate and inspire others. The authorities' ability to change their behaviour toward appropriate waste management practices is hampered by a lack of knowledge and instruction.

5. Conclusion

Referring to the objectives stated in the first chapter, it can be concluded that this study has successfully achieved its aims. From the first objective, the current practices of municipal solid waste management in Sabah have been investigated. The findings show that the most practiced solid waste management in the study area is through garbage truck collection, which eventually ends up in landfills. The second objective is to recommend the best sustainable approach in managing. The most recommended to manage waste in a sustainable approach is to implement 3R (Reuse, Reduce, Recycle) awareness among the community. Municipal waste management in Malaysia has always been a challenge that must be carefully planned and managed. Controlling the generation of MSW is one of the most effective and appropriate measures to ensure sustainability. By controlling the generation of waste, it helps to limit the amount of waste transferred to landfills. To succeed in implementing 3R, the government is accountable for playing a critical role in translating the policy from paper to action by enacting behaviour changes from top to down. Not just the government, non-government organizations and local authorities should also play their role in changing the community's attitude and mindset. Waste practitioners should continuously update the current challenges in managing waste and continually improvising Malaysia's current practices.

6. Recommendations

For future suggestions, Malaysia should consider using modern technology as a game-changer in waste management sustainability as other developing countries apply in their management system. Below are some examples of countries and their modern technology to manage waste used in our country [36]. For example:

- Sweden: In-Ground Containers. Waste is stored underground and transported through pipe systems instead of trucks. In addition, a vacuum system helps to reduce waste odors.
- Atlantic Canada: Waste Baling. Baling involves waste being placed in large compacter and compressed into cubes. It helps in reducing and preventing the blow of waste and extends the landfill lifespan.
- Durham region, Canada: Landfill Mining. Landfill mining involves the process of excavating landfills previously to recover recyclable materials, soils, and space.

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