



PLANNING MALAYSIA:

Journal of the Malaysian Institute of Planners

VOLUME 22 ISSUE 6 (2024), Page 651 – 662

EXAMINING RECYCLABLE ITEMS COLLECTION: INSIGHTS FROM MATERIAL RECOVERY COLLECTION FACILITY AND COMMUNITY RECYCLING CENTRE

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Abstract

For city administrations, urban waste management is a crucial issue since it has an impact on public health and environmental sustainability. Reducing the amount of waste that is dumped in landfills and protecting the environment requires efficient recycling programs. This study aims to evaluate the collection of recyclable items from two distinct types of recycling centres, namely, Material Recovery Collection Facilities (MRCFs) and Community Recycling Centres (CRCs). Meanwhile, it also aims to evaluate the quantity of recyclable materials that are collected from two distinct types of recycling centres. This study utilised raw secondary data provided by KDEB Waste Management Sdn. Bhd. A statistical analysis was subsequently conducted to provide insights into the composition of recyclable items at each recycling facility. From the analysis, it is shown that the MRCFs have gathered 97.29% of recyclable items, leaving the CRCs with the remaining 2.71% in total. This highlights the value of a specialised and well-coordinated strategy for managing numerous types of recyclable waste, which enhances the overall sustainability and effectiveness of the recycling program. Therefore, this study recommends that data collection activities at each recycling centre continue with some improvements, as this could aid in future analysis of recycling patterns and trends.

Keywords: Recyclable, Material Recovery Collection Facility (MRCFs), Community Recycling Centre (CFCs), KDEB, Waste Management

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INTRODUCTION

The quantification of municipal solid waste (MSW) in Malaysia has grown increasingly intricate, mirroring challenges observed in other developing countries (Kasavan et al., 2020). This complexity is fuelled by factors such as burgeoning populations, rapid urbanisation, and shifts in lifestyle, which collectively strain solid waste management systems (Yusof et al., 2019). Malaysia generates a considerable amount of waste daily, with an average of 1.17 kg per person, ranking third in the ASEAN region. Singapore leads at 3.763 kg per capita, followed by Brunei at 1.4 kg per capita (UNEP, 2017). Government statistics indicate a troubling upward trend in household waste production. The total amount of waste increased from 36,500 tons per day in 2015 to 38,150 tons per day in 2018 (SWCorp, 2020).

According to Mohd Rodzi et al. (2019), the most common form of disposal is landfilling, with very little waste being recycled (17.5%) or burned (26.5%) at home. The management of MSW presents a multifaceted challenge, with household waste contributing significantly to the composition of landfills, wherein recyclable materials constitute up to 80% of the waste stream (Shakil et al., 2023). This reliance on landfills, a predominant waste disposal method, poses considerable environmental risks, including methane emissions and leachate contamination (Chuah et al., 2023).

The pressing issue of domestic waste management has garnered attention, particularly in Selangor State, Malaysia, which stands out as the highest producer of domestic waste, with its capital city, Shah Alam, contributing significantly to this statistic (Bazrbachi et al., 2023). Statistical data highlights a discernible upward trend in solid waste generation within Selangor, escalating from 2,765,149 metric tonnes in 2018 to 3,010,831 metric tonnes in 2021 (Statistik Siri Masa MyKPKT, 2022).

Despite this surge, there is a noteworthy positive development in recycling practices among the populace, as evidenced by the increase in the recycling rate in the State of Selangor, reaching 2,602,940.62 tons in 2023, compared to just 219,920.68 tons in 2020 (Dewan Negeri Selangor, 2024). Additionally, the national recycling rate in 2023 increased to 35.38% compared to the target of 35%, with the total volume of recycled goods reaching 4.933 million metric tons. This rate is aligned with the target recycling rate set in the Twelfth Malaysia Plan, which aims for a recycling rate of 40% by the year 2025 (Syazana, 2023). The importance of recycling as a keystone of this paradigm is highlighted by the realisation of the necessity of sustainable waste management, which includes the collection, transportation, recycling, and disposal of waste without compromising environmental integrity or future well-being.

In 2016, the Selangor State Government appointed KDEBWM as the PMC to manage the solid waste collection and public cleansing services throughout Selangor. Consistent with the principles that are outlined in Malaysia's National Cleanliness Policy and the United Nations Sustainable Development Goals (SDGs), KDEBWM is actively advancing recycling programs and advocating for the reduction of single-use plastics as integral components of a circular economy framework (KDEB Waste Management, 2024). The rationale for these initiatives stems from the need to protect the environment and promote sustainable practices.

Recycling initiatives aim to preserve the environment by reducing the amount of waste that is disposed of in sanitary landfills. For instance, materials such as cans, papers, and bottles can be recycled and reused, which can help prevent environmental degradation and contribute to a more sustainable ecosystem. KDEBWM currently operates two types of recycling centres, i.e., the Material Recovery Collection Facilities (MRCFs) and Community Recycling Centres (CRCs).

Thus, this paper aims to evaluate the collection of recyclable items from two distinct types of recycling centres, namely, the Material Recovery Collection Facilities (MRCFs) and the Community Recycling Centres (CRCs) in Selangor; which are operated by KDEB Waste Management Sdn. Bhd. (KDEBWM), a Project Management Company (PMC) wholly owned by the State Government of Selangor. To ensure the quality of the secondary data retrieved, the data was meticulously acquired from recycling centres under the supervision of KDEBWM.

RESEARCH METHODOLOGY

Study Area

This study focuses on five (5) recycling centres that have been established by KDEBWM, which are strategically located in several regions in Selangor to play a role in effective waste management and recycling processes, as depicted in **Figure 1**.

KDEBWM has established five recycling centres located in Jalan Korporat in Meru, Klang; Bandar Bukit Puchong in Subang Jaya; Bukit Changgang in Kuala Langat; Cyberjaya; and PPR HICOM. Among these, the centres in Jalan Korporat, Bandar Bukit Puchong, and Bukit Changgang are large-scale facilities designated as MRCFs.

These facilities serve as collection centres where no processing of recyclables occurs. The primary source of recyclables in MRCFs is the KDEBWM garbage compactors, which employ a process known as tailgate recycling. This process involves general workers separating recyclables at the tailgate of the garbage compactors.

On the other hand, the recycling centres in Cyberjaya and PPR HICOM are classified as CRCs. The CRCs in Cyberjaya operate as a buy-back centre, where the public can sell their recyclable materials. The source of recyclables for this centre primarily comes from the public in Cyberjaya and nearby areas. The CRCs in PPR HICOM, however, is a drop-off type centre, where the public can drop off their recyclable materials for collection.



Figure 1: Location of five (5) recycling centres operated by KDEB Waste Management Sdn. Bhd.
(Source: Google Maps, 2024)

Description of Secondary Data

This study concentrates on the raw data of recyclable items collected from the five (5) recycling centres operated by KDEBWM in collaboration with several recycling partners, which include both MRCFs and CRCs. The data provided includes recycling centre types, locations, hours of operation, types of recyclables, and the total amount of recyclables collected annually.

MRCFs, such as those located in Jalan Korporat, Bandar Bukit Puchong, and Bukit Changgang, primarily serve as collection points where recyclable materials are gathered and subsequently sold to off-takers. These materials are then repurposed as raw materials for the production of new items. On the other hand, CRCs, such as the ones in Cyberjaya and PPR HICOM, function differently. These centres operate based on a buy-back and drop-off

concept. This means that the public can sell their recyclable materials at these centres or drop off their recyclables for collection.

These recycling centres are strategically situated across various municipalities, including Majlis Bandaraya Subang Jaya (MBSJ), Majlis Bandaraya Diraja Klang (MBDK), Majlis Perbandaran Kuala Langat (MPKL), Majlis Perbandaran Sepang (MPSp), and Majlis Bandaraya Shah Alam (MBSA), to facilitate easy access for the community and promote sustainable waste management practices. Regarding the operational hours, MRCFs are open six days a week, while CRCs operate 24 hours a day, every day.

All these recycling centres accept a similar range of recyclable items, including plastic, paper, scrap metal, aluminium, copper, coils, e-waste and used cooking oil. However, glass and fabric are only accepted at the Cyberjaya recycling centre. The total amount of recyclable items collected will be analysed and detailed further in the results and discussion section.

Data Analysis

The raw data provided was systematically reorganised and tabulated first using Microsoft Excel due to some missing and insufficient values. Those missing values were due to the non-availability of data provided which include (i) different types of recyclables items at each recycling centre, and (ii) different operational years. As a result, part of the data could not be shown. Only significant and required data were statistically analysed further. Most of the values and numbers from the data were converted into percentages and visualised using bar graphs and pie charts for easier comprehension.

RESULTS AND DISCUSSION

The summarised data of the recyclable items that have been gathered by five (5) recycling centres located in Selangor is shown in **Table 1**.

Table 1: Summarised data from KDEBWM for each recycling centre.

| Recycling Centre Types | | Material Recovery Collection Facilities (MRCFs) | | | Community Recycling Centres (CRCs) | |
|------------------------|------|---|----------------|-----------------|------------------------------------|---------------|
| Location | | Bukit Puchong | Jalan Korporat | Bukit Changgang | Cyberjaya | PPR Hicom |
| YEAR | 2021 | 1,799,633.00 | 1,895,719.50 | Not Available | Not Available | Not Available |
| | 2022 | 2,214,559.00 | 1,793,386.72 | Not Available | 46,076.01 | Not Available |
| | 2023 | 1,921,772.62 | 1,916,889.94 | 710,415.32 | 125,206.46 | 1526.00 |
| Total (kg) | | 5,935,964.62 | 5,605,996.16 | 710,415.32 | 171,282.47 | 1,526.00 |
| Recyclables Item | | Plastic, paper, scrap metal, aluminium, copper, coil, e-waste, oil, glass and fabric. | | | | |

As illustrated in **Table 1**, the total amount of recyclable items was only recorded in 2023. This occurred because the Bukit Changgang, Cyberjaya, and PPR Hicom recycling centres commenced operations at a later date by KDEBWM, in comparison to the Bukit Puchong and Jalan Korporat recycling centres.

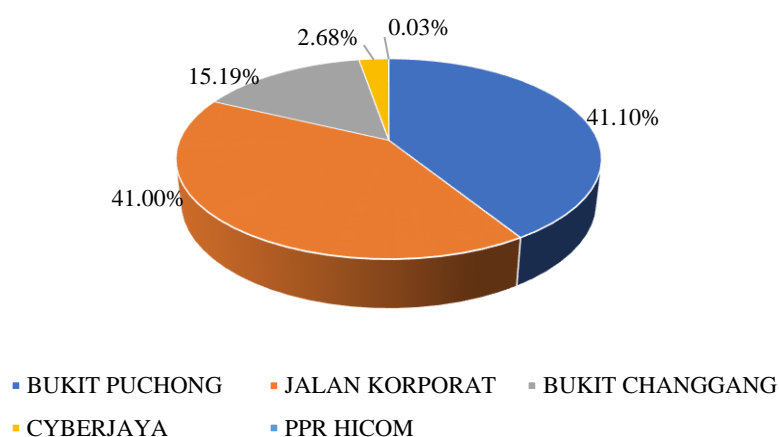


Figure 2: Total collection in year 2023 by percentages.

The descriptive data revealed significant disparities in the volume of recyclables handled by each centre, with MRCFs processing a notably higher percentage compared to CRCs.

This distribution may suggest that MRCFs play a crucial role in handling large-scale recycling volumes, which could point to their more extensive resources, accessibility, or established infrastructure. MRCFs extract valuable recyclables from complex waste streams, with their net present values and environmental impacts varying based on factors such as waste composition, fixed capital costs, and waste tipping fees, which influence profitability (Olafasakin et al., 2023). Plus, the application of optimisation models and advanced sorting technologies may improve the operational efficiency of MRCFs. Although individuals' separation may still be necessary for some materials, mechanical separation operations in MRFs enhance the quality of recyclable materials and reduce unwanted substances (Chang et al., 2005).

In contrast, CRCs, such as those in Cyberjaya and PPR Hicom, contribute minimal percentages, suggesting limitations in facility size, accessibility, or community participation rates. This contribution may be influenced by several challenges, including but not limited to seasonal and geographical variations and public perception and participation, as noted in prior

studies. Due to regional and temporal factors, the amount of waste collected at CRCs might vary substantially. As an example, statistics from Denmark showed that waste collection varied seasonally, with recyclable materials rising over time. Seasonal patterns, which are primarily influenced by visitor numbers, have an impact on the waste collected at community recycling centres. For effective planning and resource allocation, it is crucial to recognise these patterns (Edjabou et al., 2019).

Next, factors related to public perception and participation play a role. A sociological survey conducted in Italy found that the main drivers of CRC usage are respect for the environment and community engagement. Participation is also encouraged by financial incentives, such as shopping vouchers or waste fee reductions (De Feo & Polito, 2015). These factors, however, are based solely on prior studies and not on the descriptive analysis conducted in this study, which presents a research gap for further investigation into the underlying causes of the disparities between MRCFs and CRCs.

Figure 2 depicts the percentage of each recycling centre in the year of 2023. The Bukit Puchong and Jalan Korporat recycling centres each recorded approximately 41% of the recyclable items. In contrast, the Bukit Changgang recycling centre recorded only 15.19%. Meanwhile, at CRCs, the Cyberjaya and PPR Hicom centres recorded smaller amounts, at 2.68% and 0.03%, respectively. To be exact, MRCFs have gathered 97.29% of recyclable items, leaving CRCs with the remaining 2.71% in total, as illustrated in **Figure 3**.

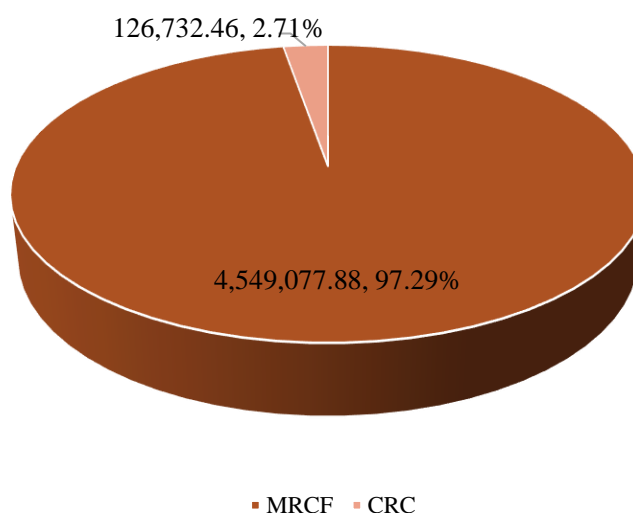


Figure 3: Total Collection by Different Types of Recycling Centres in 2023

Analysis of waste collection data as illustrated in **Figure 4** reveals a distinct division of labour between the Material Recovery Collection Facilities (MRCFs) and the Community Recycling Centres (CRCs). MRCFs are predominantly responsible for collecting the bulk of recyclable waste, including plastic (99.6%, equivalent to 2,875,536.60kg), paper (93.5%, equivalent to 906,470.83kg), and scrap metal (98.8%, equivalent to 621,830.05kg). In contrast, CRCs exclusively manage fabric (100%, equivalent to 2,741.00kg) and glass (100%, equivalent to 26,720.00kg) waste streams. A slightly balanced distribution is observed in the collection of oil (76.5% by MRCFs, equivalent to 11,032.65kg; 23.5% by CRCs, equivalent to 3,382.79 kg) and e-waste (40.4% by MRCFs, equivalent to 7,913.20 kg; 59.6% by CRCs, equivalent to 11,697.17 kg). Additionally, MRCFs are solely responsible for collecting coil (100%, equivalent to 53,663.00kg) and copper (100%, equivalent to 320.00kg) waste. While MRCFs collect the majority of aluminium waste (99%, equivalent to 72,311.55kg), CRCs contribute a minor portion (1%, equivalent to 709.78 kg). These findings, which comprise both quantitative and proportional data, emphasise the distinct responsibilities of each type of recycling facility in the waste management system and their collaborative efforts in handling a broad range of recyclable items.

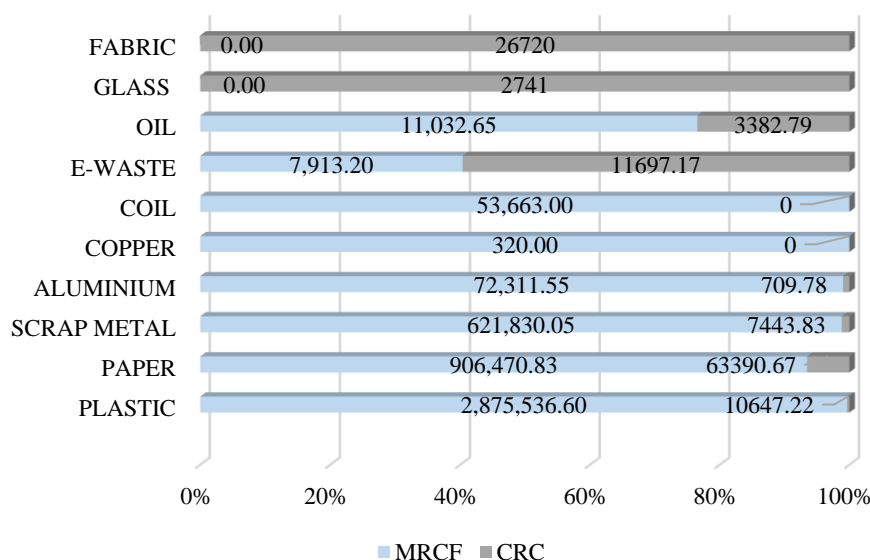


Figure 4: Total amount of recyclable items by categories for both types of recycling centres in 2023.

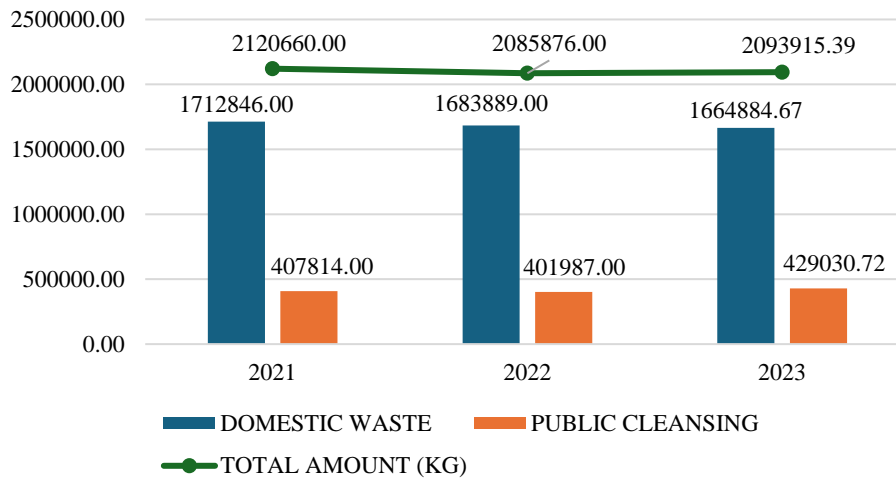


Figure 5: Solid waste generated in Selangor from year 2021 until 2023

In addition, the graph in **Figure 5** illustrates the annual quantity of solid waste generated in Selangor from 2021 to 2023. This waste is categorised into domestic waste and public cleansing waste, with the total amount also indicated. Domestic waste consistently constituted the largest proportion, exhibiting a minor decline from 1.7 million tonnes in 2021 to 1.6 million tonnes in 2023. Public cleansing waste remained relatively stable, averaging around 400,000 tonnes annually. Overall, the total solid waste generated experienced slight fluctuations, starting at 2.1 million tonnes in 2021, dipping marginally in 2022, and then reaching just under 2.1 million tonnes in 2023.

This additional information regarding solid waste generated in Selangor is crucial for understanding the dynamics of the recycling system in the future. In order to enhance recycling initiatives and tackle waste management issues, an array of strategies that foster greater public involvement and make the most of current facilities must be adopted. Based on current research, preliminary recommendations identify a number of strategies that can be used to improve recycling practices and recycling system efficiency.

Firstly, an educational initiative has been successful in improving recycling-related public awareness and behaviour. As an example, accessible recycling facilities were shown to be a significant obstacle in a pilot recycling campaign that raised awareness and participation (Chase et al., 2009). Furthermore, competitive development techniques combined with cost-effective educational interventions can significantly impact recycling and

environmental practices, producing a high impact at a low cost (Popescu et al., 2020).

In addition, enhancing the reach of recycling facilities and placing drop-off locations in more strategic areas promotes broader involvement within the community. Making recycling facilities more convenient, such as placing them near residential areas or buildings, can greatly increase recycling rates (Siu & Xiao, 2016; DiGiacomo et al., 2017).

Besides that, continuous monitoring and analysis of waste generation patterns can help refine recycling initiatives and highlight areas that need further attention. For instance, Azri et al. (2022) applied the within-cluster pattern identification (WCPI) approach in this country, employing geotagged images and k-means clustering to optimise recycling bin placement. This method aims to reduce litter and lower carbon emissions by promoting recycling through improved bin location strategies. These preliminary recommendations offer an initial basis to improve recycling facilities and participation, and they might also act as an outline for future studies on the most effective sustainable waste management strategies.

CONCLUSION

Based on the statistical data analysis, the total quantity of recyclable items that have been recorded at the three facilities under the Material Recovery Collection Facilities (MRCFs) in 2023 is significantly higher than the amount recorded at the two facilities under the Community Recycling Centres (CRCs). In comparison, CRCs only collected 126,732.46 kg of recyclables, while MRCFs recorded 4,549,077.88 kg. These disparities imply that MRCFs have a crucial role in managing high recycling volumes, most likely as a result of their greater infrastructure, accessibility, and resource availability. CRCs, on the other hand, deal with difficulties including public perception, facility constraints, and fluctuating seasonal and regional factors that affect participation rates.

Hence, this study suggests that in order to address these problems, data collection at each recycling location should be continued with improvements. Notably, an understanding of community recycling trends and patterns would be assisted by these improvements. In addition, future studies might focus on filling up the gaps found in this study, namely, in addressing the fundamental causes of the disparities between MRCFs and CRCs. This study can provide a preliminary basis for future research that aims at optimising recycling infrastructure and improving public engagement.

ACKNOWLEDGEMENTS

The authors extend their profound appreciation to Universiti Putra Malaysia for the provision of a research grant (GP-IPS/2023/9744800), which has facilitated the execution of this study. The Department of Research Grant and the Research Management Centre (RMC), in conjunction with the School of Graduate Studies at Universiti Putra Malaysia (UPM), provided invaluable support throughout the research endeavour. Additionally, recognition is extended to KDEB Waste Management Sdn Bhd (KDEBWM) for their generous contribution of data, which has been instrumental to the fruition of this research.

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Received: 19th March 2024. Accepted: 17th October 2024