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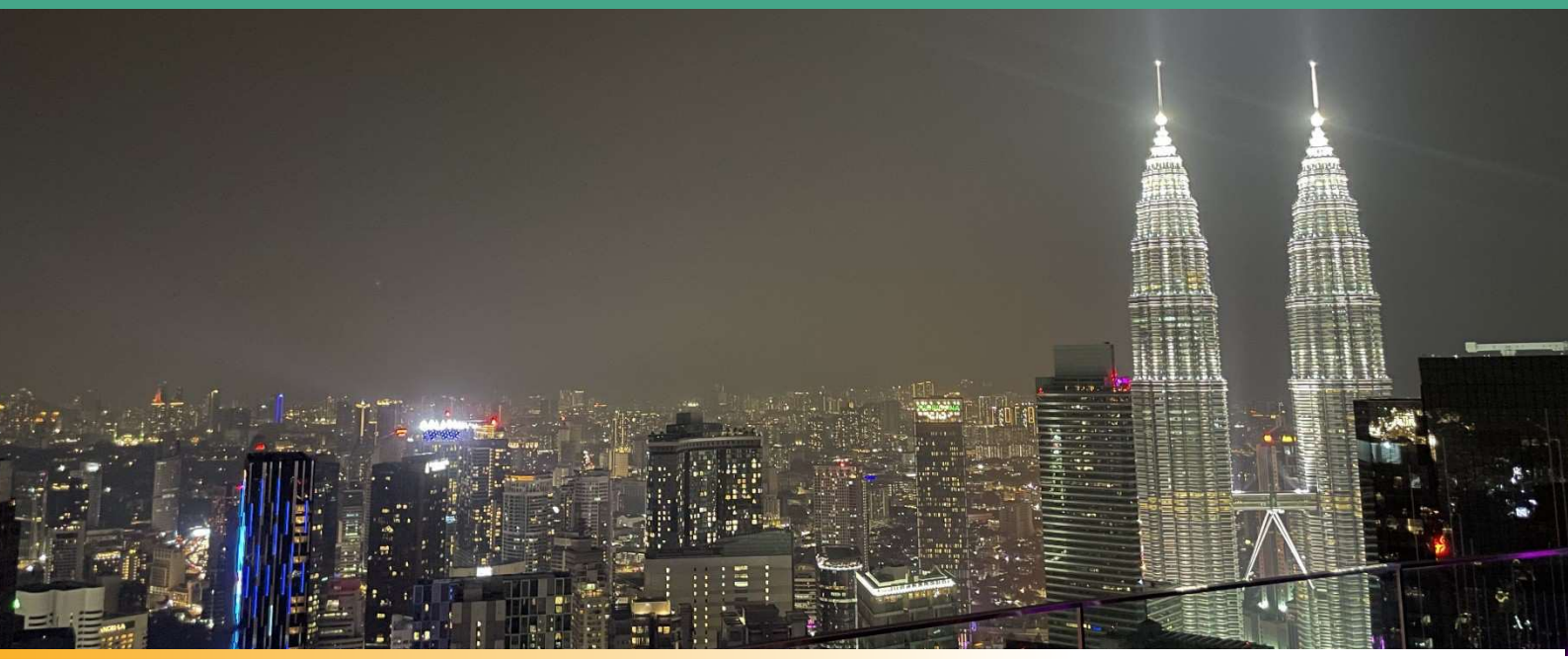
SHAPING THE CIRCULAR ECONOMY

Circular Economy Malaysia

Financial Instruments for the Sustainable Implementation of Waste Management and Circular Economy

Case Study



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LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
CEPA	Consumer Education and Public Awareness
EPR	Extended Producer Responsibility
EU	European Union
GDP	Gross Domestic Product
GNI	Gross National Income
HDPE	High Density Polyethylene
ICI	Industrial, Commercial & Institutional
JPSPN	National Solid Waste Management Agency
KPKT	Ministry of Housing and Local Government
KPWKM	Ministry of Women, Family and Community Development Malaysia
MAREA	Malaysian Recycling Alliance
MRF	Material Recovery Facility
NCEC	National Circular Economy Council
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PAYT	Pay-as-you-throw
PET	Polyethylene terephthalate
PP	Polypropylene
PRO	Producer Responsibility Organization
SSI	Separation at a Source Initiative
SST	Sales and Service Tax
SWCorp	Solid Waste and Public Cleansing Management Corporation
WtE	Waste-to-Energy plant
3R	Reduce, Reuse, Recycle
5R	Rethink, Reduce, Reuse, Recycle, Refuse

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1 INTRODUCTION

Malaysia consists of 13 states and is divided into three federal territories.[1] The country is located in Southeast Asia and is a founding member of ASEAN (Association of Southeast Asian Nations); Malaysia will assume the chairmanship of this association in 2025 under the theme of inclusion and sustainability.[2–4] Malaysia covers a total area of 330,411 km^2 and has a total population of 35.56 million in 2024. In 2000, the population was 22.97 million and has grown steadily since then.[5] In 2024, 79.2% of Malaysia's total population was urban, indicating a high degree of urbanization in the country.[6]

Malaysia is a middle-income country with a multisectoral, export-driven economy.[1] In 2024, Malaysia exported goods worth US$329.45 billion, while imports amounted to US$299.51 billion.[7] The Gross Domestic Product (GDP) amounted to US$422 billion, representing growth of 5.11% over the previous year.[5] The Gross National Income (GNI) per capita was US$11,670 in 2024; the country is expected to cross the threshold to become a high-income country between 2028 and 2030.[5, 8]

However, rising prosperity not only changes economic prospects, but also consumption and lifestyle habits. Households with higher incomes generally produce more waste than those with lower incomes.[9] The World Bank also reports a positive correlation between waste generation and income levels. Waste generation initially declines in the lowest-income countries but rises faster than in high-income countries when there are slight changes in income. By 2050, daily per capita waste generation in high-income countries is expected to increase by 19%, while in low- and middle-income countries an increase of around 40% or more is expected.[10] The increase in waste generation in Malaysia is mainly due to population growth, accelerated urbanization and industrialization, changes in consumer behavior, and economic growth.[11]

Total waste generation in Malaysia amounted to around 33,000 tons per day in the period from 2011 to 2012. The amount of waste per capita varied between 1.0 and 1.33 kilograms per day depending on the type of settlement and housing, with an average of 1.17 kilograms per person per day.[12] Waste generation is estimated to exceed 39,000 tons in 2023, which corresponds to an annual waste generation of more than 14 million tons.[12, 13] It is assumed that daily waste generation in Malaysia will increase to more than 42,000 tons in 2025.[11] The continuous increase in waste generation highlights the growing burden on national waste management. It is estimated that Malaysia's landfills will reach full capacity by 2050 at the latest if no appropriate measures are taken.[14]

For example, waste recycling in Malaysia has been improved in recent years through appropriate measures. Campaigns promoting the 3Rs (reduce, reuse, recycle) and the Separation at Source Initiative (SSI) have increased the recycling rate.[15] The recycling rate in Malaysia reached 35.4% in 2023, marking a steady increase since 2014.[13] This is a significant step towards a circular and ecological economy, but there is still room for improvement, particularly due to the aforementioned increase in waste generation, limited landfill options, and the necessary expansion of infrastructure.

To this end, the 12thMalaysia Plan (2021-2025) has formulated concrete targets: the recycling rate for household waste is to be increased to 40% by 2025. In addition, consistent separation at source and the application of the 3R principle are being pursued. The network of facilities for waste collection, separation, and recycling is being expanded in residential areas, public institutions, and commercial areas. These and other initiatives are intended to promote the implementation of a circular economy in Malaysia.[16]

In order to comprehensively outline the current situation of the waste management system in Malaysia and derive the status quo, this publication focuses on waste collection, composition, and recycling in Malaysia, as well as the political frameworks. Based on this, an evaluation of the existing structures and processes is carried out. The aim of the study is to analyze and discuss various financing instruments for the implementation of a circular economy-based waste management system, taking into account the current structures in Malaysia.

2 WASTE MANAGEMENT SYSTEM IN MALAYSIA

The waste management system in Malaysia is currently largely linear in structure. Figure 2-1 shows the current structure of waste management in Malaysia with its linear and circular material flows. Waste comes from three main sources: households; the commercial, industrial and institutional (ICI) sectors; and construction and demolition activities. The waste is collected and either disposed of in landfills or sent for recycling. Currently, the majority of waste ends up in landfills. However, suitable waste can also be processed in a waste-to-energy (WtE) plant to generate thermal energy. Recycling in Malaysia mainly involves plastics, metals, and paper.[11]

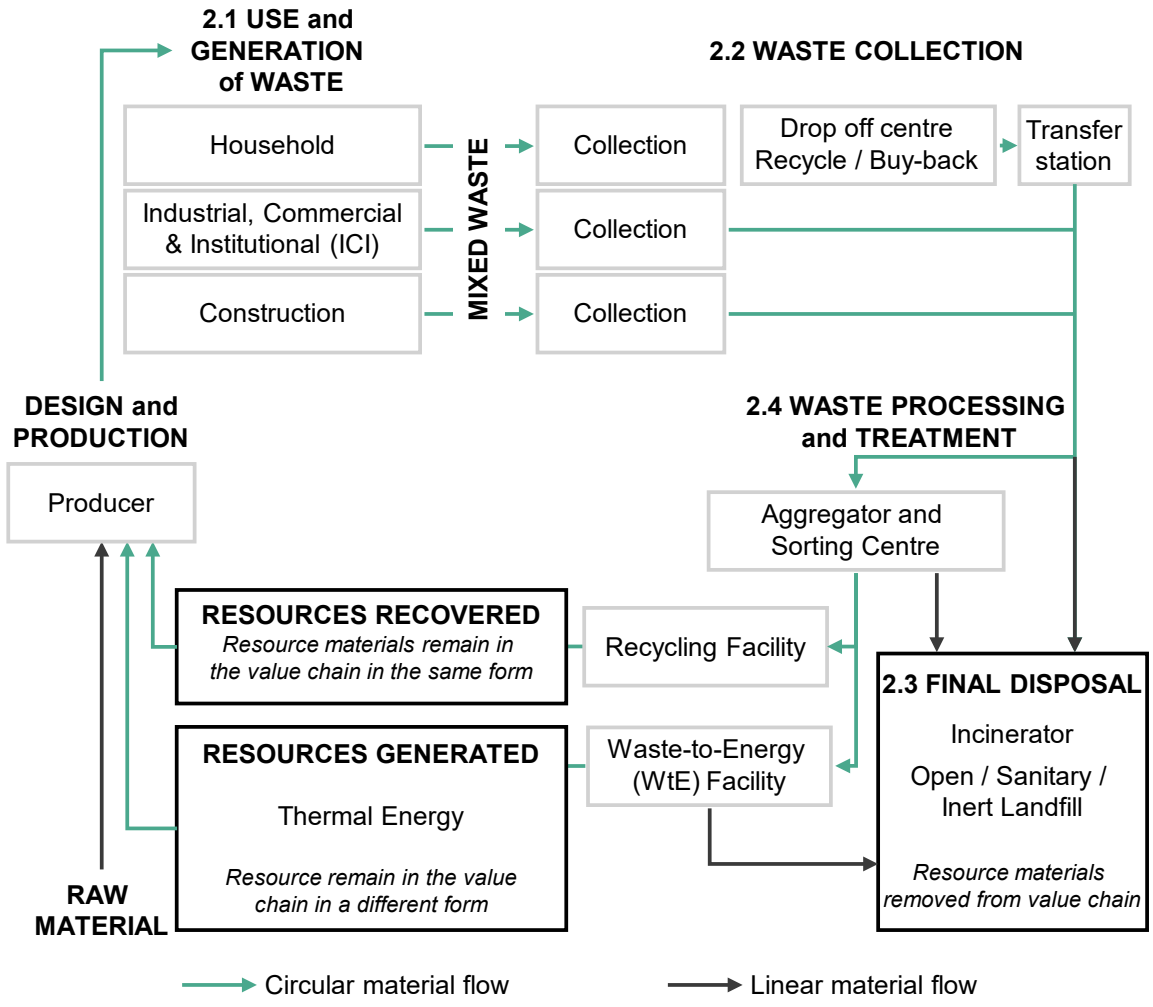

Figure 2-1 : Current waste management system in Malaysia[11,17]

The following subchapters describe the individual steps of the figure above in detail.

2.1 Waste generation and composition

In order to classify the quantities and composition of waste in Malaysia, the term *solid waste* must first be defined. The legal basis for this is the Solid Waste and Public Cleansing Management Act 2007 (Act 672), which defines *solid waste* as:

(a) any waste material or other unwanted surplus material or rejected products resulting from the application of a process;
(b) all materials that must be disposed of because they are defective, worn out, contaminated, or otherwise unusable;
(c) other materials required to be disposed of by law or other written statute by the competent authority; but excluding scheduled waste under the Environmental Quality Act 1974 (Act 127), sewage under the Water Services Industry Act 2006 (Act 655) or radioactive waste under the Atomic Energy Licensing Act 1984 (Act 304).[18]

Controlled solid waste can be classified into eight different categories under Act 672: commercial waste, construction and demolition waste, municipal waste (household waste), industrial waste, institutional waste, imported waste, public waste, and other solid waste that may be determined from time to time by regulations. Municipal waste includes all solid waste generated in households and usually produced in residential buildings, including garden waste.[18]

Knowledge of the composition of the waste stream is essential for the implementation of a sustainable and resource-efficient waste management system. Reliable data on waste quantities and the composition of solid waste in Malaysia comes from a study conducted between September 2011 and September 2012.[12] Overall, the data situation for more recent figures on waste composition in Malaysia is not very transparent, as some publications and press releases are largely based on or appear to be derived from the results of the 2011/2012 study.[13, 19, 20]

One of the publications researched uses data from the 2011/2012 study as a basis for estimating the daily and annual waste volume for a later year, taking into account current population figures. According to this, the estimated waste generation in Malaysia for the publication from 2023 is 39,054 tons per day and 14,254,715 tons per year.[13] Accordingly, the accuracy of the data, particularly regarding the current amount of waste in Malaysia, appears to be limited.

The 2011/2012 study shows that 33,130 tons of solid waste are produced daily in Malaysia. The amount of waste per capita varies between 1.0 and 1.33 kilograms per person per day, with an average of 1.17 kilograms per day. The study provides separate statistics on the composition of household waste and waste from industry, commerce, and public institutions (Industrial, Commercial, and Institutional, ICI).[12]

The total composition of household waste in Malaysia is shown in Figure 2.2. The study covered the states of the northern, central/Klang Valley, and southern regions, as well as the states of Sabah and Sarawak.[12]

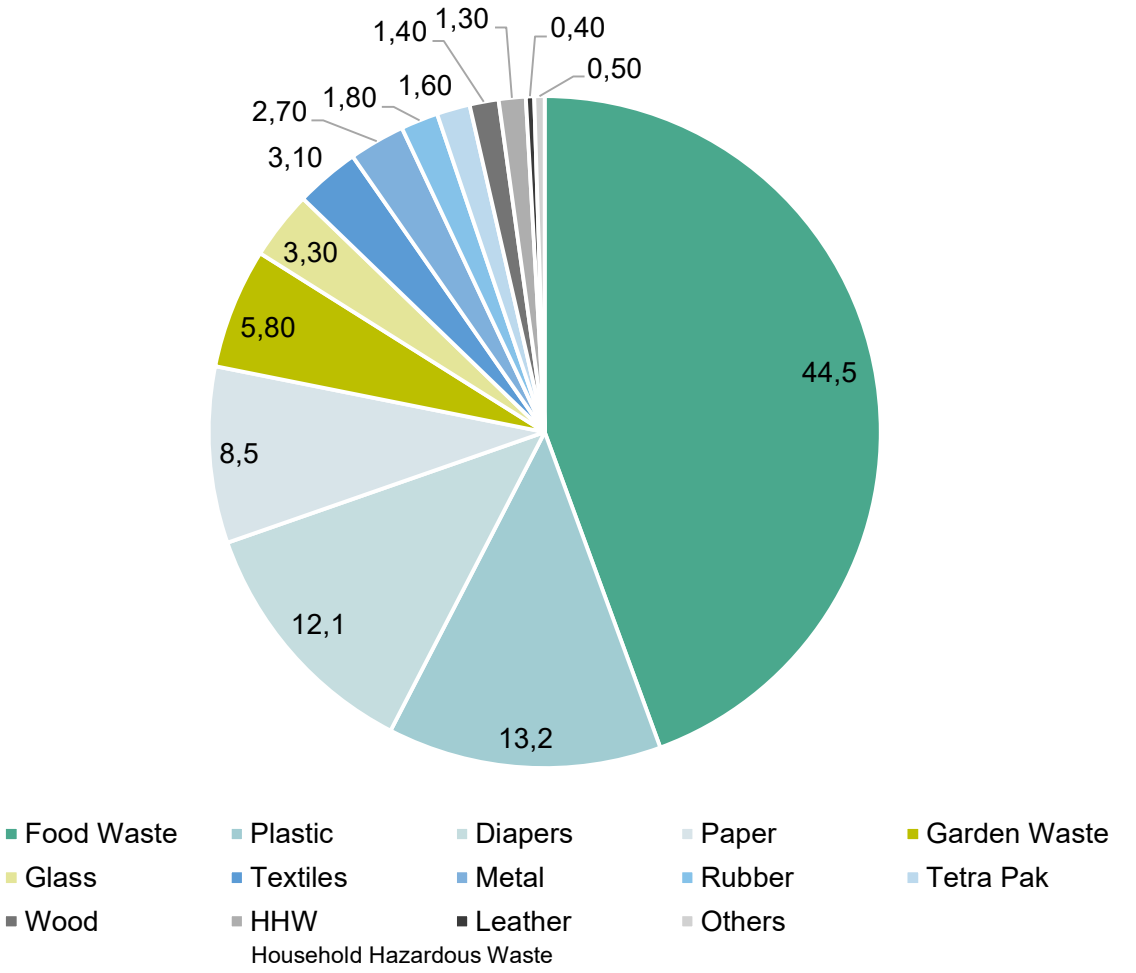

Figure 2-2 : Composition of Malaysian household waste in the period from September 2011 to September 2012[12]

Figure 2-2 shows that food waste accounts for the largest share of waste composition in Malaysia, at 44.5%. This is followed by plastics at 13.2% and diapers at 12.1%. Paper accounts for 8.5%.[12]

A study from 2003 examined the amount of energy that could be recovered from municipal waste during incineration based on its properties. It showed that municipal waste in Malaysia has a very high moisture content. This is due, on the one hand, to the tropical climate with frequent rainfall and, on the other hand, to the fact that waste is often collected in containers that are susceptible to rainwater ingress. This reduces the calorific value and makes self-sustaining incineration too low, making waste incineration uneconomical.[21]

A more recent study from 2011 also focused on the energy potential of municipal waste. It cites the amount of moist raw materials, such as garden and fruit waste in the waste stream, as the reason for the high moisture content. This study determined an average calorific value of 23,000 kJ/kg for the municipal waste collected.[22]

Against this backdrop, the implementation of measures to promote waste separation is becoming increasingly relevant. The Separation at Source Initiative (SSI) in Malaysia was introduced under Act 672 in September 2015 and came into force in 2016.[17, 23, 24] Under this initiative,

households in the states covered by Act 672 are required to separate recyclable materials from other household waste.[24] Households have the option of selling their recyclable materials to recycling companies or placing them next to their trash cans for collection.[25] Although the Separation at a Source Initiative was introduced several years ago, there are still challenges in terms of household participation.

A 2022 publication conducted a study on the lack of citizen participation in SSI in Klang Valley, Malaysia. Five obstacles or challenges to the implementation of SSI were identified. These include a lack of enforcement by local authorities, inadequate facilities (no separate trash cans), awareness raising, promotion of incentives, and suggestions for the future (educational and promotional measures).[26]

The principle of separation at source applies exclusively in Act 672 states, but not in non-Act 672 states; implementation is therefore left to the discretion of the latter.[17] A comprehensive explanation of Act 672 and non-Act 672 states is provided in chapters 2.2 and 2.5. The importance of waste separation in non-Act 672 states has also been examined in various studies.

A study focusing on a district on the east coast (Panji, Kota Bharu, Kelantan) of the Malaysian peninsula conducted a survey on the separation of household waste. Waste separation among the respondents can be classified as low. The number of those who separate their waste was almost identical to the number of those who do not. This indicates that there is room for improvement in the population's awareness of household waste separation.[27]

Another study focused on the densely populated city of Ipoh (Perak). It showed that awareness of the recyclability of certain types of household waste, such as food or garden waste, is limited. It also became clear that the application of the 3R principle is more widespread in urban areas than in rural regions due to greater awareness and a better-developed infrastructure for applying the 3R principle.[28]

The 3R principle stands for reduction, reuse, and recycling. Reduction means reducing the amount of waste at source by changing consumer behavior, but also by improving manufacturing processes. Reuse means using a product multiple times, and recycling implies processing waste for other processes.[29]

The above studies show that the Malaysian government needs to run more campaigns and awareness-raising activities to fully implement the Separation at Source Initiative and the 3R principle. Only by consistently implementing these measures can the quality of waste be improved and its suitability for efficient recycling processes be sustainably increased.

2.2 Waste collection

Municipal waste management is organized differently in some Malaysian states. This is related to political structures (according to the Local Government Act 1976): On the peninsula, the KPKT (Kementerian Perumahan dan Kerajaan Tempatan), also known as the Ministry of Housing and Local Government (MHLG), is responsible for municipal waste management, while a separate ministry is responsible for the states of Sabah and Sarawak on Borneo.[30–32] A further distinction is made between states that apply the Solid Waste and Public Cleansing Act 2007 (Act 672) (Act 672

states) and those that do not implement it (non-Act 672 states).[30] The eight states/territories that currently apply the Solid Waste and Public Cleansing Act 2007 (Act 672) include Kedah, Pahang, Negeri Sembilan, Melaka, Johor, Perlis, Federal Territory of Kuala Lumpur, and Selangor.[33] Figure 2-3 illustrates the hierarchy of waste management and highlights the differences in municipal waste management between Act 672 and non-Act 672 states.

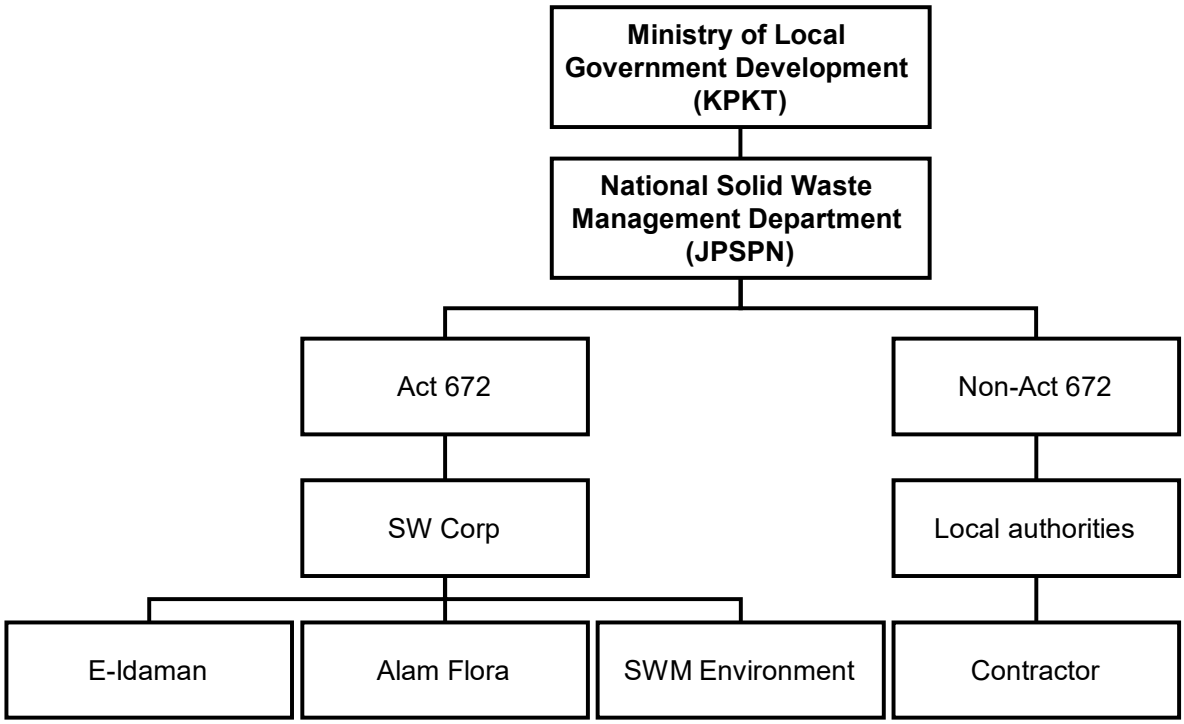

Figure 2-3 : Waste management hierarchy[34]

The KPKT's tasks include developing strategies and advising the federal and state governments and local authorities on waste management and public cleaning. The aim is to make these services more efficient, effective, comprehensive, and at the same time more cost-effective.[35]

Following the passage of Act 672, the National Waste Management Agency (Jabatan Pengurusan Sisa Pepejal Negara, JPSPN) was established under the KPKT.[17, 34, 36, 37] The main functions of the JPSPN include the enforcement and implementation of laws and regulations, in particular Act 672. In addition, the privatization of waste management and public cleansing, the approval of construction projects, and the operation and closure of facilities are among the tasks of the JPSPN. The JPSPN is also responsible for approving the import of plastics and for introducing new facilities and technologies.[37] The KPKT established the Solid Waste and Public Cleansing Management Corporation (SWCorp) in 2008, based on the Solid Waste and Public Cleansing Management Corporation Act 2007 (Act 673).[17, 30, 34]

Among other things, SWCorp is responsible for organizing and monitoring the collection, transport, treatment, and disposal of solid waste in its designated regions of Malaysia. It operates under the supervision of the KPKT and implements the waste management and public cleansing concepts developed by the JPSPN.[17, 38]

Formal sector

The formal sector is operated by licensed waste disposal companies. In Act 672 states, concessionaires are responsible for the collection, transport, and disposal of municipal waste, while in non-Act 672 states, contractors, which are private waste disposal companies, perform these tasks.[30, 34] In non-Act 672 states, the state government sets the guidelines and requirements for waste management. Local authorities implement the guidelines and employ the appropriate contractors.[17]

There are three main concessionaires in the Act 672 states. Their areas of responsibility are divided into the north, south, east, and central regions.[34] E-Idaman Sdn Bhd is responsible for waste management and recycling in the north of the peninsula, in the states of Perlis and Kedah.[30, 39] Alam Flora Sdn Bhd provides waste disposal services for several concession areas, including the federal territories of Kuala Lumpur and Putrajaya and the state of Pahang, which are located in the center and east of the peninsula.[30, 40] Services include the collection of household waste and non-hazardous waste, as well as public cleaning, such as street cleaning.[41] SWM Environment Sdn Bhd operates in the south of the peninsula and provides services such as waste and recyclable material collection and public cleaning. SWM Environment Sdn Bhd also operates two landfills in Johor and Melaka.[30]

Recyclable materials are collected once a week and household waste is collected twice a week (2+1 rule).[17, 24] There are currently five transfer stations in Malaysia, located in Johor (1), Pulau Pinang (2), Selangor (1), and Kuala Lumpur (1).[13]

Informal sector

The informal sector includes non-governmental organizations (NGOs) and private collectors, which include individual waste collectors as well as larger organized groups. The informal sector is present both in the states regulated by Act 672 and in the other states.[17, 30]

The actors in the informal sector collect a large proportion of the recyclable materials generated by end consumers and thus play an important role in the recycling industry. However, they compete with the formal sector. High-quality recyclable materials are mainly collected by the informal sector, which reduces the potential value of the waste stream for the formal sector. Furthermore, the recycling and market shares of the informal sector are difficult to quantify.[30]

2.3 Waste disposal

The proportion of municipal waste disposed of in landfills varies considerably in different reports. One report estimates that by 2022, around 95% of waste in Malaysia will be disposed of in landfills.[42] Another source states that an estimated 82.5% of solid waste will end up in landfills in 2021.[43] For 2017, it was reported that 95% of collected waste is landfilled, while the remaining 5% is processed in waste treatment facilities.[44] These differences highlight the varying data available on landfill waste and treated waste in Malaysia, but nevertheless show the trend that waste in Malaysia is predominantly disposed of in landfills. In addition, it is predicted that landfills in Malaysia will reach their capacity limits by 2050 at the latest.[14]

In Malaysia, landfills can be classified as non-sanitary (unsecured), sanitary (secured), or inert. According to the KPKT statistical report, there are currently 114 non-sanitary, 22 sanitary, and 5 inert landfills in Malaysia.[13] Most landfills are open dumps where few measures are taken to prevent environmental pollution.[17] Secure landfills are divided into four levels that address various environmental and health aspects. These include promoting urban waste disposal, maintaining a healthy sanitary environment in and around the landfill, reducing environmental pollution, accelerating stabilization through leachate, and minimizing the impact on the groundwater system through controlled leachate management.[45] The Green Technology Master Plan Malaysia 2017-2030 sets out the goal of having 80% secure landfills by 2030.[44] Inert landfills are used, for example, for the disposal of sand and concrete.[14]

There are four waste incineration plants in Malaysia, located in Kedah (1), Pahang (2), and Perak (1).[13] Waste incineration has been used as a technology in Malaysia since 1996, but there is no fully functioning incineration plant due to the varying composition and properties of waste, which is too moist or too oily for incineration. Furthermore, incineration plants in Malaysia are small in size and therefore have limited capacity.[46]

2.4 Waste recycling and treatment

Malaysia has various waste processing and treatment facilities. Waste-to-energy (WtE) plants, for example, can be used to generate energy from waste.[44, 47] The most important methods of generating energy from waste include pyrolysis, anaerobic digestion, incineration, gasification, and landfill gas recovery. The main objectives of WtE are to generate energy, reduce the consumption of primary resources, and reduce waste generation.[47] WtE enables a reduction in waste volume of approximately 90%, which reduces the capacity load on landfills.[44] In Malaysia, a WtE plant was built in the state of Negeri Sembilan.[13] The WtE plant was designed by the company Cypark Resources Bhd specifically for wet waste and began operating in Ladang Tanah Merah (Negeri Sembilan) in 2022.[48, 49] According to the Green Technology Master Plan Malaysia 2017-2030, a total of three WtE plants are to be in operation by 2030.[44] However, a more recent report from 2024 indicates that the Housing and Local Government Ministry plans to build six WtE plants in Malaysia by 2025.[50] But, the high investment costs for WtE plants are particularly challenging for Malaysia, which is why the government is developing financing methods for the implementation of such plants.[44]

Another option for waste treatment is material recovery facilities (MRFs). These facilities sort recyclable materials such as cardboard, paper, plastics (HDPE, PET, PP), steel, aluminum, and tin and press them into bales.[51] An initiative from the Blueprint for Solid Waste in Malaysia 2025-2035 aims to establish material recovery facilities in order to increase the recovery of recyclable materials and reduce the amount of waste. To this end, a feasibility study is to be carried out to determine, among other things, the estimated upgrade costs, the willingness of landfill operators to build an MRF facility, and the form of investment.[11] A previous publication indicates that two MRFs are in operation in Malaysia, located in Sungai Udang, Melaka, and Temerloh, Pahang. This information is based on interviews with government and industry representatives conducted in 2021.[46] Further research did not reveal any reliable data on this subject.

Recycling

While the recycling rate in Malaysia was still 13.2% in 2014, it rose to 30.7% in 2020.[13] For 2020, SWCorp reported that the amount of recycled waste in the seven states was 4,267,043.80 tons.[25] The goal was to achieve a waste recycling rate of 22% by 2020.[63)] This percentage has therefore already been exceeded. The 12th Malaysia Plan, which covers the period from 2021 to 2025, aims to achieve a recycling rate of 40% for household waste by 2025.[16] In 2023, the recycling rate was 35.4%.[13] More recent data could not be identified during the research. However, it should be noted here that the recycling rate only takes into account the states in which SWCorp operates. Furthermore, the statistics only refer to household waste; the commercial and industrial sectors are not legally required to report recycling rates.[46]

Currently, most industries use raw materials from imports, as local recycled materials are limited. In addition, most local waste is contaminated, making it unsuitable for recycling. Local recycled materials need to be improved to close the gap between supply and demand, which would enable a reduction in imports of residual materials.[11]

Overall, however, it is clear that the recycling rate in Malaysia should be further increased. A key issue here appears to be the contamination of waste, which makes it difficult to use efficiently in incineration plants, but also in WtE plants or material recovery facilities (MRFs).

2.5 Legal framework

Waste management in Malaysia is governed by a broad legal framework of laws, guidelines, and plans that have been developed in recent years by the Malaysian government and regulatory authorities, among others. Figure 2-4 illustrates selected laws, guidelines, and plans related to environmental aspects and waste management in Malaysia along a timeline. These are discussed in detail in the following section.

In the 1970s and beyond, Malaysia initially had no policy or legislation specifically addressing comprehensive solid waste management.[53] The Environmental Quality Act 1974 (Act 127) applies nationwide to all regions of Malaysia and focuses on reducing, monitoring, and preventing environmental pollution, thereby creating a legal framework for improving environmental quality, but not for comprehensive solid waste management.[53, 54] The Street, Drainage and Building Act 1974 (Act 133) introduces a uniform system for road construction, drainage and building in the local administrative districts of the Malaysian peninsula.[55] The Local Government Act 1976 (Act 171) applies in Peninsular Malaysia and contains, among other things, regulations on environmental pollution, in particular water pollution.[56] These two laws also do not cover solid waste management in sufficient detail and comprehensively enough.[53] However, the Local Government Act 1976 (Act 171), in conjunction with other laws and regulations, transferred responsibility for establishing, implementing, and maintaining sanitation services to local authorities. Local authorities organized waste collection themselves or contracted out this task to private contractors. The state government took over the administration of local authorities and provided land for disposal facilities.[53, 56, 57]

The development of the Action Plan for a Beautiful and Clean Malaysia (ABC Plan) in 1988 by the Ministry of Housing and Local Government (MHLG) was considered the first specific provision for

solid waste management in Malaysia.[53, 57–59] The ABC Plan included guidelines for the expansion of solid waste management in Malaysia, which dealt with the management of municipal solid waste in a general sense. The ABC Plan addressed, among other things, the collection, disposal, reduction, and recycling of municipal solid waste.[53, 58, 59] However, the ABC Plan was never officially adopted or fully implemented.[53] Many elements of the ABC Plan were later incorporated into the National Strategic Plan for Solid Waste Management.[60]

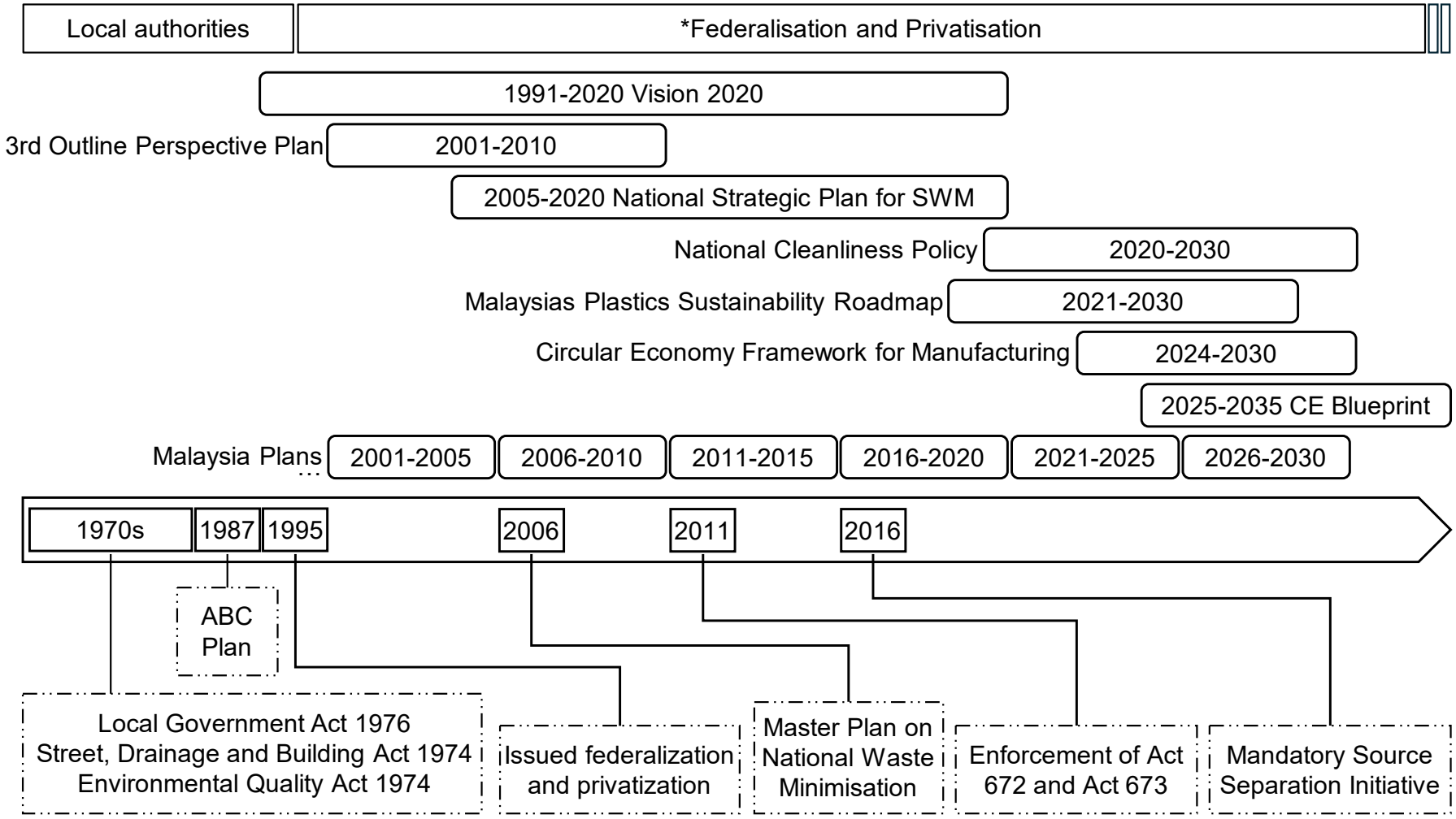

Figure 2-4 : Timeline of Solid Waste Management and Policies in Malaysia[57,58,59,60]

The Malaysian government had set itself two goals that directly influenced the quality and scope of solid waste management services.[53] On the one hand, Vision 2020 from 1991 created a basis for developing Malaysia into an industrialized country by 2020. Vision 2020 identifies challenges that must be overcome in order to achieve the goal of becoming a fully developed country. These include, for example, the challenge of developing a fully competitive, dynamic, resilient, and robust economy.[53, 61] On the other hand, the Malaysian government signed the Rio Declaration in 1992 and committed itself to pursuing the principles of sustainable development.[53]

In 1995, the government decided to restructure waste management through privatization and federalization and appointed private concessionaires in this context.[53, 57] Federalization pursued several key objectives. The aim was to develop a national waste management policy and ensure its implementation. At the same time, it was intended to promote the regional expansion of infrastructure such as interim treatment facilities and landfills. In addition, it was aimed to ensure that the technical systems used were in line with national requirements and had been thoroughly tested. Finally, it was intended to enable the provision of the necessary financial resources, for example through privatization programs, in order to relieve the financial burden on the population at the outset.[53]

Period 2001-2005

This was followed by the 8th Malaysia Plan, which covered the period 2001-2005. During this period, the collection and disposal of solid waste was to be improved through complete privatization. As part of the implementation of an integrated waste management system, a transfer station and a waste incineration plant were to be built in Kuala Lumpur. In order to address existing challenges in waste reduction, reuse, and recycling (3R), the government discussed a comprehensive waste management policy. Corresponding studies and pilot projects were to determine the feasibility and acceptance of the waste recycling industry. Furthermore, local authorities were to be encouraged to introduce various initiatives and economic incentives, such as fee models, to reduce the amount of household waste. For industrial waste, separate disposal facilities were to be created in industrial parks.[62]

The 9th Malaysia Plan stated that despite efforts to promote 3R through a national recycling campaign, the amount of solid waste recycled was less than 5% of the total waste disposed of. During the 8th Malaysia Plan, the government established two landfills in Seelong, Johor, and Bukit Tagar, Selangor, as well as a transfer station in Taman Beringin, Selangor.[63]

With the 3rd Outline Perspective Plan (2001-2010), the government considered introducing a comprehensive waste management policy. This included the construction of incineration plants for efficient waste disposal. In addition, the Ministry of Housing and Local Government (MHLG) continued the 3R initiative in 2001.[58, 59]

Period 2006-2010

From 2006 to 2010, the 9th Malaysia Plan was implemented. Waste management was based on the National Strategic Plan for Solid Waste Management (NSPSWM).[63] The NSPSWM was developed to serve as a guide for planning and resource allocation based on national priorities and joint decisions, and is in line with Vision 2020.[53] The plan established the guidelines, strategies,

and procedures for waste management in Malaysia and served as a guide for planning and resource allocation. To implement the NSPSWM, existing institutions, laws, and regulations in the field of waste management are being reviewed and infrastructure is being improved. Within the NSPSWM, the focus is on prevention, reuse, and recycling (3R) as well as on the provision of suitable facilities and technologies. Priority is to be given to the construction of smaller and more manageable disposal facilities. A new waste management department is being set up under the MHLG to take over the planning and management of waste, including financial management.[63] At the same time, public awareness campaigns are being expanded to encourage greater public participation in waste management programs and projects.[63] In addition, a Master Plan on Solid Waste Minimization at the national level is to be formulated to strengthen the institutional capacities of the authorities and raise awareness in society of the need to minimize waste and commit to a recycling target of 22% by 2020.[63]

In 2006, the Master Plan on National Waste Minimization (MWM 2006) was introduced to establish a clear vision, strategies and roles for the relevant actors in reducing waste generation in Malaysia. The guiding principle here is to create a material cycle economy in which waste prevention measures are firmly integrated into the behavior of the private sector, the population and the government. The MWM sets out waste prevention strategies and concrete action plans for the federal government and local authorities.[64]

Period 2011-2015

The 10th Malaysia Plan was effective during the planning period from 2011 to 2015. During this period, the government was to complete its efforts to restructure waste management by federalizing waste management and public cleansing and fully enforcing the Solid Waste and Public Cleansing Management Act 2007. The aim was to transfer responsibility for waste management and public cleansing from local authorities to the federal government.[65] With the entry into force of the Solid Waste and Public Cleansing Management Act 2007 (Act 672) in 2011, the government assumed responsibility for waste management.[15, 57] Act 672 regulates the disposal of controlled solid waste and public cleansing. Among other things, this is intended to ensure adequate sanitary conditions.[18] The aim of Act 672 was to improve the quality of waste management and cleaning services nationwide and to create uniform standards.[15]

The Solid Waste and Public Cleansing Management Corporation Act 2007 (Act 673) is a law establishing the Solid Waste and Public Cleansing Management Corporation, which is responsible for the administration and enforcement of regulations relating to solid waste disposal and public cleansing, as well as all related tasks.[66] The Solid Waste and Public Cleansing Management Corporation Act (Act 673) established two institutions to ensure the implementation of the Solid Waste and Public Cleansing Management Act 2007 (Act 672). Firstly, the National Solid Waste Management Department (Jabatan Pengurusan Sisa Pepejal Negara, JPSPN) was established as the regulatory authority. Secondly, the Solid Waste and Public Cleansing Management Corporation (SWCorp) was established to take over the responsibilities of local authorities.[15, 57] The government planned to completely privatize the collection of household waste to three concessionaires.[65]

According to the 10th Malaysia Plan, the federalization of waste management was expected to bring about several concrete improvements, as local authorities would be able to focus more on licensing, enforcement, planning, and development. These include hygienic waste transport using modern vehicles and standardized collection containers, more frequent waste collection - two to seven times a week depending on the type of location -, the Separation at Source Initiative, the closure of unsecured landfills, of which a total of 112 were shut down by 2015, and the subsequent remediation of individual sites to secure landfills.[65] In addition, transfer stations, integrated material recovery facilities, sanitary landfills, and other disposal and treatment facilities are to be built. The separate collection of garden waste, bulky waste, and recyclables from other household waste will continue in order to facilitate recycling and recovery.[65] The possibility of requiring private individuals to separate waste at source will be examined. The government will demand greater commitment to improved waste management from manufacturers in particular, for example through 3R. In this context, a deposit return system and a take-back system will be introduced.[65]

The11th Malaysia Plan highlights the following successes in solid waste management for the period 2011-2015. The household recycling rate rose from 5% in 2010 to 10.5% in 2012. As of 2013, the recycling of paper had saved four million tons of CO_2 equivalents in greenhouse gas emissions. Furthermore, 159 companies with a total processing capacity of over 24,000 tons per month were officially licensed to recover electrical and electronic waste.[67]

Period 2016-2020

The 11th Malaysia Plan was developed for the period from 2016 to 2020. With regard to waste management, it mentions that this should move closer to the 3Rs, thereby reducing the development of new landfills.[67] The 11th Malaysia Plan describes a life cycle approach to waste that goes beyond mere waste disposal and aims to increase recycling and recovery rates, thereby improving landfill management.[67] During the 11th Malaysia Plan, investments in programs to raise awareness of the 3Rs continued. In addition, Separation at Source continued to be an important tool for achieving the 2020 recycling target (22%).[67] The Separation at Source Initiative came into force in 2016.[23] The use of waste as a resource (conversion into energy, etc.) gives it economic value and reduces industry's dependence on natural resources. The private sector can drive these initiatives forward and ensure the financial viability of such projects.[67]

Period 2021-2025

The 12th Malaysia Plan covers the period from 2021 to 2025 and pursues various game changers, one of which is called Embracing the Circular Economy.[16] The linear economy is to be restructured into a circular economy in most sectors in Malaysia.[16] To promote circular economy, concepts such as Extended Producer Responsibility (EPR), the polluter-pay and user-pay principles, and forms of self-regulation in industry, are being promoted.[16] Companies are to be encouraged to implement more environmentally friendly measures by using economic instruments, environmental subsidies, and green financing incentives.[16]

In implementing EPR, manufacturers should be held accountable for the treatment and disposal of post-consumer products, either through action or financial contributions.[16] The

implementation of EPR is supported by the manufacturer take-back system and the application of user-pay or polluter-pay principles.

Waste should be managed holistically and sustainably, including through consistent Separation at Source and the ongoing strengthening of the 3R initiative. To this end, waste separation and recycling facilities will be expanded, particularly in residential areas, institutions, and commercial areas. In addition, measures will be taken to reduce single-use plastics. These measures are in line with the National Cleanliness Policy 2019*,* which aims to reduce environmental pollution from waste and promote the circular economy.[16] One of the goals is to increase the recycling rate of household waste to 40%.[16]

In 2019, the Minister of Housing and Local Government (MHLG) announced the formulation of the National Cleanliness Policy.[68] The National Cleanliness Policy aims to raise awareness of cleanliness among the population, improve hygiene in public spaces, and at the same time make the environment more sustainable. It also promotes initiatives that convert waste into economically usable resources in order to drive the transition to a circular economy. Five clusters have been formed to implement the National Cleanliness Policy, focusing on the following areas: awareness of cleanliness, environmental sustainability, circular economy, governance and enforcement, and quality and skilled workforce.[68]

Malaysia's Plastics Sustainability Roadmap began in 2021 and is designed to run until 2030, focusing specifically on plastics. The roadmap describes the strategic framework with which Malaysia intends to shape the transition to a sustainable and circular plastics economy. It focuses on issues such as improved product designs and collection and sorting systems. A key element is the gradual introduction of instruments such as EPR.[69]

In 2024, the Circular Economy Policy Framework for the manufacturing industry in Malaysia was published and is in line with the strategies and objectives of the 12th Malaysia Plan.[70] The framework was developed taking into account global developments, a comprehensive inventory of the current state of the circular economy in Malaysia, and a detailed benchmarking of leading international circular economy strategies and indicators. Based on this analysis, the framework formulates key objectives and guiding principles for Malaysia in four core areas: circular inputs, efficient processes, sustainable outputs, and socioeconomic impacts.[70]

The Blueprint for Solid Waste in Malaysia 2025-2035 was developed to accelerate the transition to a circular economy for solid waste management in Malaysia. A key approach of the Blueprint is the introduction of a mandatory EPR mechanism, which makes manufacturers responsible for sustainable waste management throughout the entire product life cycle. This measure is to be implemented gradually. Currently, the costs of household waste disposal are borne entirely by the federal government/PBN/PBT. Manufacturers of products/goods and other stakeholders along the value chain are only responsible for ensuring that products meet certain health and safety standards. The implementation of the EPR system extends responsibility for the disposal of solid waste to manufacturers. Within the framework of so-called Producer Responsibility Organizations (PRO), manufacturers are obliged to create joint systems for the return and recycling of materials, thus ensuring the orderly treatment of products after their useful life.[11] The

implementation of EPR is intended to reduce the costs of waste disposal borne by the state by sharing the costs of solid waste disposal with the manufacturers of the products.[11]

Another mechanism is PAYT (pay-as-you-throw), which is to be levied on the basis of the quantities of waste disposed of by the ICI and development sectors. PAYT is a mechanism for levying charges for waste disposal. The PAYT initiative aims to encourage a reduction in the quantities of waste transported to landfills. The implementation of PAYT will encourage the ICI sector and the construction industry to further implement Separation at Source and thus contribute to recycling targets.[11]

PAYT aims to motivate waste producers to reduce the amount of solid waste they generate. CEPA (Communication, Education and Public Awareness) is important for the success of PAYT, as it raises public awareness of the importance of separating solid waste. PAYT targets all solid waste, including recyclable waste generated by the ICI sector and the construction sector, and promotes responsible waste management.[11]

Period 2026-2030

A draft document is available for the 13th Malaysia Plan (2026-2030). This plan continues to address the issue of the circular economy and addresses the improvement of waste management. Laws on the circular economy are being drafted to monitor activities along the entire value chain (from production to disposal). Furthermore, circular economy mechanisms such as plastics recycling, biowaste management, scheduled disposal, and EPR are being improved. Mixed financing and appropriate tax incentives to promote the treatment of food waste directly at source are also being expanded. These are also being extended to the institutional sector.[52]

Public participation will be encouraged through initiatives such as the introduction of a pay-as-you-throw system and the establishment of buy-back and smart recycling centers. Solid waste disposal services in rural areas will be improved. To accelerate the circular economy, a ban on the opening of new landfills will be implemented and existing landfills will be rehabilitated. At the same time, the construction of waste-to-energy plants will be expanded through public-private partnerships. Furthermore, alternative waste management methods such as composting, biological processing, and the implementation of the 5R (Refuse, Reduce, Reuse, Recycle, Recover) approach will be examined.[52]

2.6 Assessment and classification of the status quo

Previous research shows that there is still room for improvement in Malaysia's waste management system. In particular, recycling and incineration are only possible to a limited extent due to the frequent contamination of waste, which makes it difficult to implement a circular economy. The introduction of initiatives such as SSI has been examined in various studies. This showed that greater focus should be placed on awareness campaigns in order to raise public awareness of the issue. The continued mention of the 3R principle in Malaysia's plans in recent years also makes it clear that this principle does not appear to have been fully implemented and is being further developed with 5R. Furthermore, the informal sector plays a decisive role in the collection of recyclable materials, thereby reducing the value of the waste stream for the formal sector. The share of recyclable materials accounted for by the informal sector is not known. Overall, the data

available on recycling, waste quantities, and waste composition is limited. The factors described above make it difficult to implement a financing structure for waste recycling in Malaysia.

Various approaches are listed in the legal framework described above, which are to be implemented in the coming years. These include initiatives such as EPR and PAYT, which are to be introduced for industry and the general public. However, the documents do not fully address how these initiatives are to be implemented. The following chapters therefore describe financing instruments for waste recycling and present a case study that discusses the instruments described using Malaysia as an example.

3 FINANCING INSTRUMENTS

3.1 Description of financing instruments

The financing of waste recycling is a key challenge worldwide. On the one hand, the provision of collection and recycling infrastructure requires high fixed costs, but on the other hand, there are political and social demands for cost fairness, ecological control effects, and social compatibility. From an environmental economics perspective, financing instruments can be divided into three main categories: the instruments considered include producer-based instruments, tax instruments, and fee and levy systems.

Producer-based instruments

Extended producer responsibility (EPR) is a financing model based on the polluter pays and precautionary principles. In this context, manufacturers are obliged to bear the costs of taking back, recycling, and disposing of their products at the end of their life cycle.[71] This is usually done through collective fund models, to which companies contribute according to their production volume or material use.

EPR systems have two main effects: first, they provide a stable source of income for waste management, as financing is directly linked to manufacturers. Second, they create incentives for ecologically efficient product design by allowing companies to save costs when they bring more durable, easier-to-recycle, or more resource-efficient products to market.[72] Empirical studies, particularly from the EU and Japan, show that EPR systems lead to significantly higher recycling rates and a reduction in landfill waste.[73]

EPR systems for packaging have been established in the EU since the 1990s.[74] In Germany, for example, the Green Dot was introduced in 1991, a system in which private dual systems organize packaging collection in exchange for license fees from manufacturers.[75] This system has been continuously developed (currently regulated by the Packaging Act) and has achieved impressive results: according to the Federal Environment Agency, the recycling rate for packaging waste in Germany was around 68.5% in 2022, and over 80% according to the Green Dot – both figures exceed the EU target of 65%.[7677]

The high success rate is attributed to robust requirements, competition among several packaging disposal systems/producer responsibility organizations (PROs), and public awareness, among other factors. France, Sweden, Belgium, the Netherlands, and Japan also have EPR systems for packaging, which have led to significant increases in recycling rates. [78]

In Japan, for example, the Containers and Packaging Recycling Law requires manufacturers to pay recycling fees and help organize disposal. Since then, large portions of plastic and paper packaging have been recycled. Japan, for example, achieves over 84% PET bottle recycling.[79]

Tax instruments

Environmental consumption taxes do not directly serve as instruments for covering specific disposal costs but rather pursue the goal of internalizing external costs. The theoretical basis for this

dates back to Pigou (1920), who demonstrated that negative external effects such as environmental pollution can be internalized by imposing a tax equal to the marginal social costs caused.

In the context of waste management, such taxes can take the form of packaging taxes, levies on disposable products, or tax surcharges on short-lived consumer goods. The effect of these measures manifests itself in two ways. On the one hand, they generate government revenue that can be earmarked for investment in waste management and recycling. On the other hand, they have a steering effect by motivating consumers to choose alternatives that generate less waste. The Organization for Economic Co-operation and Development (OECD) emphasizes that environmental consumption taxes are particularly effective when they are broad-based, administratively simple, and transparent.[80] However, they often have regressive distributional effects, as low-income households have to spend a larger proportion of their income on goods subject to consumption tax. [81]

In practice, there are several international precedents for such excise tax incentives:

- Plastic bag taxes: Many countries have introduced special taxes on single-use plastic bags. One example is Ireland, where a tax of €0.15 per plastic bag was introduced in 2002. This resulted in a ~90% decline in plastic bag consumption within a short period of time.[82] Other EU countries and cities report similar results – the steering effect of such clearly defined disposable products is enormous, and the revenue has been fed into environmental funds, for example. Sweden introduced a plastic bag tax (SEK 3 per bag) in 2020, which significantly reduced per capita consumption (from ~80 to less than 20 bags/year).[83]

- Beverage and snack taxes: Although primarily motivated by health policy, taxes on sugary drinks or junk food show a similar mechanism. Mexico reduced sales by around 7% through a soft drink tax[84] , and some US cities saw double-digit declines in sugary beverage consumption.[85] These experiences can be transferred: a moderate consumption tax of around 10% can lead to a 5 to 10% reduction in consumption.[86] The difference to environmental issues is that the relevance to waste is indirect (less consumption = less packaging waste).

- Differentiated VAT in favor of the circular economy: Some countries also use the tax lever positively by giving tax breaks to environmentally friendly alternatives. Sweden and Finland, for example, have reduced VAT on repair services and second-hand goods (e.g., in Sweden from 25% to 12% for bicycle and textile repairs).[87] This aims to promote long-term use. Conversely, an increase in tax on short-lived new goods would be conceivable to achieve the same effect (i.e., a penalty for less sustainable goods).

- Fast fashion tax: A current example is France's law against fast fashion. It includes an eco-module on cheap clothing, effectively a tax of initially €5 per item of clothing sold in the fast fashion sector, rising to €10 by 2030. This tax is intended to make extreme disposable fashion less attractive. At the same time, advertising restrictions and information requirements are being introduced.[88] This shows that even in complex areas such as textiles,

consumption taxes are being implemented politically to reduce waste (in this case, textile waste).

Fee and levy systems

Fees and charges are classic financing mechanisms in the field of waste recycling. As a rule, these charges are levied directly on households or businesses to cover the costs of waste collection, treatment, and disposal. According to the polluter-pays-principle, waste producers bear the costs of waste disposal.[89]

A specific model in this category is the pay-as-you-throw (PAYT) system, in which households pay according to the actual amount of waste disposed of or the volume of waste containers. Empirical studies in Europe and North America show that PAYT leads to a significant reduction in residual waste volumes, while at the same time increasing the separate collection of recyclable materials.[90] The fee-based approach thus not only serves as a source of financing, but also has a steering function: waste prevention is financially rewarded, while excessive waste production is penalized.

This can be implemented in various ways:

- Sale of fee bags or stickers that must be affixed to garbage bags. Only garbage in official bags included in the price is collected (e.g. in many US cities such as Seattle or European municipalities, there are municipal garbage bags that must be purchased).

- Use of bins of different sizes with a graduated fee rate or weighing systems where bins are weighed when emptied and billed to the nearest gram (e.g. some municipalities in Switzerland, Germany, and Italy).

- Or the *choice tariff* principle, where households subscribe to a certain volume of waste (e.g. 120 L bin with fortnightly emptying) and pay extra for additional bags.

The aim is to give citizens economic incentives to avoid waste and recycle. Every garbage bag saved means cost savings, which motivates people to collect more recyclable materials separately, which can often be disposed of free of charge or at a lower cost. PAYT thus consistently operationalizes the polluter-pays-principle on a small scale – similar to water or electricity consumption, the amount of waste is calculated based on consumption.

PAYT systems are already in place in thousands of communities worldwide. In the US, over 7,000 municipalities have introduced similar models.[91] Well-known examples include cities such as San Francisco and Seattle, but also medium-sized towns and rural counties. In Europe, Germany, Belgium, the Netherlands, Italy, Sweden, Switzerland, and Austria, among others, have introduced volume-based waste disposal fees in many municipalities.[92]

In South Korea, a mandatory PAYT system (using official garbage bags) was introduced nationwide in 1995, which drastically reduced urban waste generation and increased the recycling rate.[93] In 2000, Taiwan implemented a "per-bag fee" in Taipei: waste must be disposed of in special bags that are subject to a fee. This helped to reduce per capita waste generation in Taipei by

almost 40% and increase the recycling rate to over 15% within a decade.[94] In the Swiss capital Bern, residents have been paying per official garbage bag (around CHF 1.40 for 35 liters) since 2003, while recyclables are collected free of charge. This has led to a noticeable reduction in waste.[95] In Italy, many northern Italian municipalities (e.g. in South Tyrol or Veneto) have weight-based fees; studies there show significant reductions in waste volumes.[96] Belgium (Flanders) introduced *pay-as-you-throw* bags across the board, which greatly reduced the amount of household waste and gave Flanders one of the highest recycling rates in Europe.[97] In Massachusetts (USA), cities with PAYT generated an average of 30% less residual waste per household in 2020 than cities without PAYT (approx. 1239 pounds vs. 1756 pounds per household/year). This corresponds to ~560 kg vs. ~800 kg – a saving of ~240 kg of waste per household per year thanks to PAYT.[98] The fees collected in the PAYT system can also be used to finance recycling structures.

3.2 Theoretical evaluation of the financing elements

The mode of operation and examples from other countries have already been presented for each model. This is followed by an assessment according to the (environmental economic) criteria of efficiency, effectiveness, accuracy, and complexity.

Extended producer responsibility (EPR)

A well-designed EPR system can be economically efficient, as costs are borne directly by the polluter and market incentives for cost reduction are created. Manufacturers are incentivized to adopt eco-design through modulated fees (recyclable or less material-intensive packaging is subject to lower fees). EPR thus internalizes external disposal costs and rewards efficient product design.[71]At the same time, competition between PROs (as in Germany) can ensure cost efficiency. However, administrative costs are incurred—registration, monitoring, and enforcement must be organized. With low volumes or an opaque market structure, administrative costs can be relatively high.[99]

EPR is considered an effective tool for increasing recycling rates and reducing waste volumes. By having manufacturers bear the disposal costs, the polluter-pays-principle is implemented and the burden on the public sector is reduced. Experience shows that mandatory EPR systems achieve significant increases in collection and recycling.[100] In Europe, for example, the recycling rate for packaging has risen steadily since the introduction of EPR requirements, e.g. the plastic packaging recycling rate across the EU has increased from ~25% in 2005 to over 40% by 2022.[101] In countries with consistent EPR implementation, waste volumes have also been reduced.

EPR is specifically targeted at certain waste streams – typically packaging, electronics, batteries, etc. It thus focuses the instruments precisely on the products that generate waste. In the case of packaging, for example, the costs are borne by packaging manufacturers and distributors, i.e., those who can control the choice and quantity of materials.[100]This controlling effect distinguishes EPR from flat-rate levies: it directly affects the industry whose behavior is to be changed (design for recycling, financing of collection).[71]

EPR is also effective because it does not burden the entire population but only affects the consumption of the products in question.[78] However, EPR does not cover all types of waste – it focuses on defined product streams. EPR does not offer a direct solution for residual waste (e.g. non-recyclable waste, organic waste). In this respect, it is a targeted instrument that should be used in combination with other measures (e.g. fees or taxes for residual waste).[71]

EPR is considered the most complex financing instrument, as it requires close cooperation between the state, industry, and society.[97] Its implementation requires a clear legal basis, national harmonization, and the establishment of specialized structures such as producer responsibility organizations.[100] In addition, producers must be registered, contributions collected, and their proper use monitored to prevent free riding.[99] The integration of federal responsibilities and the involvement of informal collection systems also increase organizational and administrative complexity.[71 78]

Environmental consumption taxes

From an administrative perspective, excise taxes are very efficient because they build on existing tax systems. No new infrastructure is needed to collect fees from each household; instead, the system ties in with companies/retailers that already pay sales tax.[102] Tax revenue flows centrally and can then be distributed. This minimizes administrative costs compared to, for example, a pay-as-you-throw system with millions of individual fee notices.[103] In addition, consumption taxes have a broad tax base—many small amounts add up, which reduces fluctuations.[104] From an economic perspective, such taxes are a correction of market prices: environmental and disposal costs are taken into account in the price (internalization). This is efficient as long as the tax roughly corresponds to the external damage – i.e. the Pigou tax principle. However, one aspect is critical: sales taxes are primarily fiscal instruments; differentiating them according to environmental considerations can create economic distortions.[102] One efficiency advantage is the flexible allocation of revenue – the government can target investments where the benefits are the greatest (e.g. modern recycling facilities, promotion of recycling markets, etc.). However, there are potential side effects: if the tax is very high, manufacturers could try to circumvent taxation (e.g. by relabeling products as more durable than they are or shifting to informal sales). This would reduce efficiency and accuracy.[104] Overall, moderate consumption taxes are generally inexpensive to collect and direct resources in the desired direction, making them an efficient policy tool, provided that social costs are addressed.[103]

Excise taxes can be very effective in influencing consumption patterns, provided that demand is sensitive to price changes. For everyday products, price elasticity is often moderate (essentials react little, luxuries tend to react more strongly).[102 105] Nevertheless, practical examples show that even moderate taxes have noticeable behavioral effects: the success of the plastic bag charge (up to 90% reduction in consumption)[82] and beverage taxes[84 85] demonstrates the potential. For waste policy, this means that a cleverly designed environmental consumption tax could encourage waste prevention by prompting consumers to choose more durable or unpackaged alternatives. This directly targets waste prevention – the highest level of the waste hierarchy. In addition, such taxes generate revenue, which in turn contributes to effectiveness because it can be reinvested in the system (e.g. financing recycling systems, public awareness campaigns, etc.).

However, effectiveness depends heavily on the level of the surcharge and the availability of alternatives. If the tax rate is too low, the steering effect remains limited – studies warn that taxes that are too low do not bring about major changes in consumption, but at least generate revenue.[104] If it is very high, the steering effect increases, but it could encourage undesirable behavior (e.g. evasion into the informal market or smuggling in the case of high product taxes if there are cheaper, possibly illegal alternatives). This correlation is advantageous for financing recycling structures: a small increase in (specific) consumption taxes places little burden on consumers, is likely to lead to minor adjustments in consumption, and can thus provide stable financing flows.[103]

The challenge with consumption-based eco-taxes lies in defining the tax base. What exactly are "short-lived consumer goods"? Accuracy depends on whether the products to be taxed are clearly and sensibly defined.[102,103] Some categories are obvious: single-use plastic items (e.g., disposable tableware) have a very short useful life and quickly end up in the trash – a tax here would be very accurately targeted at a waste problem. It becomes more difficult with products that have a heterogeneous useful life. Take clothing, for example: a T-shirt can be discarded after being worn five times (fast fashion) or used for years. A general "textile tax" would apply across the board, including high-quality, durable clothing. France is attempting to solve this problem by specifically targeting large fast fashion retailers and designing the levy as an "anti-disposable" signal.[88]

Excise taxes are less complex to implement than EPR because they build on existing tax mechanisms.[104] The main challenge here lies in the political and substantive definition of the taxable product groups and in mitigating the social consequences. A decision must be made as to which goods are considered "short-lived" or "waste-intensive" and how to ensure that low-income households are not disproportionately burdened. The complexity is therefore more political and social in nature, while the administrative effort remains relatively low.[103]

Pay-as-you-throw (PAYT)

Economically, PAYT appears to be fair and efficient, as everyone pays according to the waste disposal services they use. This means that no resources are wasted – households optimize their behavior to save costs, which is desirable from a societal perspective (less waste = less environmental impact, lower public waste disposal costs).[92] It can be argued that PAYT increases welfare by reducing unnecessary consumption of disposable products.[91] From an operational perspective, PAYT also generates revenue that makes waste disposal and recycling more cost-effective. Municipalities that charge per unit can finance their waste collection and recycling logistics without resorting to general tax revenues.[71]

However, the administrative burden of PAYT is not trivial: mechanisms for volume recording and bag sales are required. This necessitates, for example, the distribution of chargeable bags, possible adaptation of waste collection vehicles (in the case of weighing systems), and, above all, monitoring (to prevent abuse such as illegal dumping).[106] These systems work smoothly in highly organized municipalities, but in other contexts, circumvention strategies may arise (illegal dumping, burning on private property, etc.). However, studies show that illegal disposal usually increases only marginally—if at all—under PAYT and is far less than the amount of waste saved.[71] For example, shortly after its introduction in Italy, there was a slight increase in illegal dumping,

but this declined after a few months due to controls and habituation.[107] Also relevant for efficiency are economies of scale – a comprehensive system in densely populated areas can be operated more efficiently than isolated solutions.[96]

PAYT is internationally recognized as one of the most effective measures for reducing municipal waste volumes. Numerous studies confirm its significant impact. A meta-analysis by the OECD shows that volume-based fees result in 20–30% less residual waste on average. [71] Recent empirical studies using methods such as difference-in-differences corroborate these findings: in municipalities in Italy, Switzerland, and Sweden, reductions of ~18–30% were measured after the introduction of PAYT.[92 97] A recent study from Italy even found an average decrease in household waste of ~50% with a simultaneous increase in recycling volumes of 32%.[107] These high figures indicate that not only did recycling shift, but there was also a significant reduction in absolute waste (less consumption or more durable use). In practice, many municipalities report that significant effects occur quickly after introduction: citizens respond promptly by separating waste more effectively (to save on fees) and shopping more consciously. In Waterville (USA), for example, the amount of recycling tripled after the introduction of PAYT, while the amount of residual waste was halved.[91] Similar "before and after" figures come from Korean and Taiwanese cities.[9394]

PAYT not only has an initial effect but also contributes to a further decline in the total amount of waste (including recycling) over the years, as less waste is disposed of overall. However, the effect flattens out after a few years – a new, lower level per household is reached, which then remains relatively stable.[71]

PAYT is very targeted in principle, as it directly charges for the disposal of unwanted residual waste. Those who produce a lot of residual waste (which society wants to avoid) pay a lot; those who produce little and recycle a lot pay little. This means that it targets precisely those who generate waste.[92] Unlike consumption taxes, which only have an indirect effect, PAYT starts at the end of the chain, where behavior (separating vs. throwing away) is specifically influenced. In this respect, the steering effect is precise: the price signals immediately with every garbage bag: "do you really want to throw away so much, or can you avoid/recycle some of it?" This accuracy is also reflected in the fact that false incentives can be minimized; for example, recycling and organic waste usually remain free or significantly cheaper (through cross-subsidization), motivating citizens to separate waste correctly.[97] Of course, PAYT has its limits: it only applies to household waste. It does not affect industrial waste or large-scale illegal disposal. Furthermore, PAYT does not address the root cause of product design; it only applies to citizens. But within its scope (household waste), it is probably the most accurate instrument.[71]

The only problem cases are multi-unit buildings without individual allocation of waste quantities – here, accuracy can suffer because communal bins are difficult to divide up according to who produced the waste. Solutions include identifiable garbage bags for each apartment or chip card systems.[91] Accuracy is also limited when people evade the system, e.g. by disposing of their garbage in public bins (free riders). This can be counteracted by controls or technical measures.[106]

PAYT is less systemically complex in its structure, but it does involve operational and technical complexity. It requires local solutions such as chargeable garbage bags, chip cards, or weighing systems that enable user-based billing. In addition, controls and accompanying public relations

work are necessary to curb abuse such as illegal disposal. The complexity here therefore lies primarily at the level of practical implementation in municipalities, rather than in national legislation or financial architecture.[71]

All three financing and steering instruments examined – EPR, excise taxes, and pay-as-you-throw – have the potential to improve waste recycling and promote the circular economy. They work at different levels. EPR targets manufacturers (upstream), excise taxes target consumer goods (midstream), and PAYT targets waste disposal (downstream). A tabular comparison of the core characteristics illustrates the differences:

Table 1 : Summary of the theoretical evaluation of the financing elements

Financing element	Impact target	Efficiency	Effectiveness	Accuracy	Complexity
Extended Producer Responsibility (EPR)	Financing recycling, ecodesign incentive	**High** Costs are internalized according to the polluter pays principle	**High** Increase in recycling rates	**High** Targeted at defined waste streams	**Medium - high** Introduction of new legal system
Environment-related consumption taxes	Waste prevention at source, revenue for the system	**High** Administrable via existing tax system, flexible allocation	**High** Increase in recycling rates	**Medium** Depends on the selection of taxed goods	**Low** Easy to implement
Pay-as-you-throw (payt)	Waste reduction & recycling through incentives, cost recovery for collection	**High** In the long term: less waste to lower disposal costs	**Very high** Proven tool worldwide	**High** In household waste sector, financial burden correlates directly with the amount of waste	**Medium** Local implementation necessary

4 CASE STUDY: FINANCING SOLUTIONS FOR MALAYSIA

4.1 Scaling international models to Malaysia

The selection of suitable financing instruments for waste management in Malaysia must be based on the economic fundamentals of environmental financing, while also taking into account the country's institutional and socioeconomic conditions. While classical approaches to environmental economics (Pigou; Baumol & Oates) emphasize the internalization of external effects through taxes or fees, practical implementation requires adaptation to the specific circumstances in Malaysia: federal responsibilities (Act 672), underfunding of existing systems, and social heterogeneity with a significant vulnerable income population.

The instruments examined are not mutually exclusive – on the contrary, they can complement each other. EPR ensures that manufacturers take responsibility and that the financing of recycling infrastructure is strengthened; consumption taxes reduce the volume of problematic disposable products and generate immediate revenue; PAYT mobilizes households to behave better and puts municipal financing on a solid footing. A mixed approach is recommended for Malaysia in order to exploit synergies:

- In the short term (next 1–2 years): Introduction of a moderate consumption tax on selected disposable items, as this is the fastest to implement administratively. Parallel preparation of EPR legislation with pilot projects in cooperation with the Malaysian Recycling Alliance (MAREA) and international partners. Planning of PAYT pilot communities (e.g. in one city per state), accompanied by awareness campaigns.

- Medium term (3–5 years): Implementation of mandatory EPR nationwide for packaging (if necessary, initially mandatory in Act 672 states, then gradually in others). Gradual expansion of PAYT in urban areas as soon as the technical requirements (separate collection system, digital verification possible) are in place. Extend or adjust excise duty if necessary after initial experience (e.g. increase if steering is too low, or exceptions if undesirable social effects occur).

- Financing and use of revenues: Revenues from the consumption tax and the PAYT system should be earmarked for a waste/recycling fund (Solid Waste and Public Cleansing Management Corporation, SWCorp). This could be used to finance the expansion of the recycling infrastructure, the construction of the planned waste-to-energy plants, and the remediation of open landfills. In particular, part of the additional revenue should be used to cushion distributional effects, e.g. by subsidizing waste collection fees for those in need or investing in municipal services in poorer neighborhoods to achieve indirect redistribution.

- Social support: A socially balanced design is essential to ensure public acceptance. The National Circular Economy Council (NCEC) should work closely with social ministries and consumer associations to develop compensation mechanisms. If the additional burdens can be made transparent and redistributed fairly, legitimacy will increase. Public relations

work should convey that "waste less, pay less" is the motto – in other words, households can control costs through their own behavior, which emphasizes fairness. At the same time, it must be clear that no one should be left in need because of waste disposal fees.

- Monitoring and adjustment: Monitoring the impact is crucial for all instruments. Indicators should be defined (e.g. per capita waste volume, recycling rate, revenue vs. cost recovery, citizen satisfaction after introduction, illegal dumping rate, etc.). This data can be used to fine-tune the systems. For example, it is conceivable to adjust the tariffs after two years of PAYT if either a much higher reduction has been achieved (and there is a surplus) or if targets have not been met. Excise duties can also be adjusted: if it turns out that a product is still being used excessively, the tax rate can be increased or, if necessary, a ban can be considered (if tax is not enough, see e.g. plastic bags: first a fee, then a ban if there are still too many in circulation). EPR systems should be subject to regular evaluations in terms of collection rates, cost efficiency, and producer compliance.

4.2 Revenue management and fund distribution

The Solid Waste Management and Public Cleansing Corporation (SWCorp) is the ideal central institution for revenue management and fund distribution in Malaysia. SWCorp already has mandates in the areas of household waste management, licensing, and enforcement in the Act 672 states and could therefore act as a "financial management unit". Pooling financial flows at SWCorp would have several advantages: revenue from EPR levies, PAYT fees, tax surcharges, and bond issues would be collected and managed centrally and distributed to municipalities, private operators, and investors according to clearly defined criteria. This would allow funds to be targeted where they have the greatest environmental and economic impact.

The handling of revenues by SWCorp should be accompanied by a clear administrative structure that ensures transparency and accountability. This includes a publicly accessible annual budget, independent auditing, and a digital monitoring and reporting system. Such structures strengthen the confidence of the population, industry, and investors. Experience from Germany shows that acceptance of waste fees and EPR contributions increases when revenues and expenditures are reported in a transparent manner by the Federal Environment Agency and dual systems. Japan and South Korea also rely on regular transparency reports and independent supervisory bodies to ensure that fees and producer contributions actually flow into the promotion of the circular economy.

A key principle is the strict earmarking of revenues. Funds generated through PAYT, EPR, or taxes should not flow into the general government budget, but should be used exclusively for the expansion of the circular economy. This includes:

- financing the separate collection of household waste,
- the operation and expansion of sorting and processing facilities,
- investing in logistics and digital systems for service verification,
- promoting reuse and the use of secondary raw materials in industry.

Germany uses earmarked funds in EPR systems (dual system), while Japan finances investments in state-of-the-art recycling technologies with a combined fee and producer model.[111] [112] South Korea relies heavily on PAYT and links the revenue to municipal recycling and composting programs.[93] These examples show that earmarking is a key success factor in ensuring economic efficiency and the achievement of environmental goals.

Targeted promotion of the circular economy

SWCorp should allocate revenues according to strategic priorities. In the first phase, the focus will be on expanding separation systems, separate collection logistics, and securing basic sorting capacities. In a second phase, funds can be increasingly directed toward innovative technologies (e.g. Recycling 4.0, digital tracking systems) and the promotion of recycled material markets. At the same time, social compensation mechanisms are necessary to ensure that vulnerable income groups are not disproportionately burdened. International experience suggests that targeted subsidies for low-income households or basic allowances in the PAYT system help to increase social acceptance.

4.3 Social impacts and distributional effects

The introduction of new financing instruments in Malaysia's waste management and recycling sector has a direct impact on various income groups. Households in the lower income deciles – including many in rural areas and workers in the informal sector – are disproportionately affected, as taxes and fees account for a larger share of their disposable income. Statistics show that low-income households in Malaysia spend a large proportion of their budget on basic goods and everyday consumer goods.[108][109] Price increases resulting from EPR, PAYT, or Sales and Service Tax (SST)-based levies can therefore have a greater impact on these groups than on wealthier households.

Another aspect is the urban-rural divide. While PAYT models are technically feasible and effective in urban agglomerations (e.g. Kuala Lumpur, Penang), there are greater risks in rural areas: there, insufficiently controlled fee adjustments could lead to illegal waste disposal, which increases the environmental and health burden, especially for vulnerable population groups.

Targeted compensation measures are necessary to ensure that the reforms are socially acceptable:

- Basic allowances in the PAYT system
    - In Malaysia, every household, regardless of income and place of residence, could receive a free basic quota for residual waste disposal and/or recycling. Households that produce more waste would contribute disproportionately to the financing, encouraging recycling. This model takes household size into account and avoids overburdening poor families.

- Social tariffs and transfer mechanisms

    - Social tariffs can be implemented in a targeted manner via the existing eKasih system[110] , Malaysia's national database for low-income households. PAYT fees or EPR-related price surcharges could be subsidized or compensated for registered households.

- Tax exemptions for basic goods/food
    - With a selective increase in SST for short-lived consumer goods, basic foods such as rice, oil, and sugar, as well as essential products, could be exempted from the tax. This would protect the purchasing power of lower income groups while maintaining the steering effect on non-essential, waste-intensive products.

- Redistribution according to the double dividend principle
    - Part of the revenue from EPR and SST funds could be channeled into targeted redistribution programs, for example in the form of environmental vouchers or direct transfers to low-income households. This combines ecological steering with social justice and is in line with the principles of progressive environmental financing.

The political feasibility of social compensation measures in Malaysia depends heavily on social acceptance and the federal governance structure. Experience from other countries shows that reforms can fail if social aspects are not taken into account. In Malaysia, it would make sense to involve SWCorp, together with the Ministry of Women, Family and Community Development Malaysia (KPWKM), in the design of social compensation mechanisms.

5 CONCLUSION AND OUTLOOK

The analysis has shown that, despite existing progress, Malaysia's waste management system continues to face significant challenges. The increasing volume of waste, limited landfill capacity, and partially contaminated waste streams are hampering the transition to a functioning circular economy. Although policy frameworks such as the 12th Malaysia Plan and initiatives such as Separation at Source or the 3R principle exist, their implementation often remains incomplete. The examination of financing instruments makes it clear that neither a single model nor isolated measures are sufficient. Instead, a mix of instruments comprising extended producer responsibility (EPR), consumption-based taxes, and pay-as-you-throw (PAYT) offers the greatest impact. EPR enables polluter-pays financing and promotes eco-friendly product design. As an incentive instrument, consumption taxes can reduce the consumption of short-lived products while generating stable revenues. PAYT directly motivates households to avoid and separate waste, which can increase the recycling rate. From a political perspective, the three instruments offer different advantages: EPR relieves the burden on the national budget through private participation and is partly supported by industry – at least publicly, as the MAREA example shows – but is legally and organizationally complex. Excise taxes are comparatively easy to implement and generate immediate revenue, but they often meet with resistance from consumers and can be sensitive in terms of economic policy, as they dampen consumption. PAYT has the most direct ecological impact, but requires the most fine-tuning at the local level, as well as sufficient administrative capacity and citizen discipline. For Malaysia, this could result in a sensible sequence: first, a financial basis should be created through excise taxes, then the system can be improved through EPR and the targeted expansion of infrastructure, while at the same time PAYT pilot projects and accompanying campaigns promote a change in awareness in order to ultimately involve all households. Overall, it is clear that a combination of economic incentives, a clear legal framework, and consistent earmarking of revenues is necessary to secure the long-term financial basis of Malaysian waste management.

In the coming years, it will be crucial to implement the objectives formulated in the 12th and 13th Malaysia Plans. Key steps include the introduction of a mandatory EPR system that makes manufacturers more accountable for financing recycling infrastructure and designing products more sustainably. In addition, the expansion of PAYT models should be promoted, starting with pilot projects in urban regions supported by digital systems. A socially balanced design, for example through basic allowances or social tariffs, is crucial for acceptance. The targeted use of excise taxes also offers great potential, as moderate taxes on disposable and short-lived consumer goods can both generate revenue and bring about behavioral change. At the same time, institutional structures must be strengthened and the role of SWCorp as the central financing and control authority further expanded, accompanied by transparency and monitoring mechanisms. Equally important is social cushioning to avoid negative distributional effects, as well as more intensive awareness-raising among the population through informational and educational campaigns that deepen understanding of waste separation and resource conservation. In the long term, an integrative approach combining economic incentive systems, technological innovation, and social involvement will enable Malaysia not only to achieve its recycling targets but also to play a pioneering role within the ASEAN region in the transition to a circular economy.

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APPENDIX

Model variants and quantitative assessment of financing solutions in Malaysia

Optimizing the financing of a sustainable recycling economy in Malaysia requires the development of multiple model variants based on different financing instruments. The aim is to cover both the ongoing operating costs for the separate collection and sorting of recyclable materials and to enable the necessary investments in modern recycling and processing infrastructures. The calculations are based on the current waste and recycling situation: Malaysia produces around 14.24 million tons of municipal solid waste annually, of which around 4.933 million tons were recycled in 2023, corresponding to a recycling rate of 35.38%.[12] [13] The national target is 40% by 2025. This results in a residual waste volume of around 9.3 million tons per year.[16]

The operating costs of the recycling industry are conservatively estimated at around MYR 300 per ton. This figure is based on international benchmarks for the operating costs of sorting facilities (MRFs), which are around USD 45–50 per ton, and additional expenses for separate collection (Techno-economic study, 2017; World Bank, 2022). For Malaysia, this results in annual OPEX of around MYR 1.48 billion based on current recycling volumes. To achieve the 40% rate, an additional 0.66 million tons would have to be processed, requiring a further MYR 0.20 billion. Added to this are investment costs for new sorting facilities. A single-stream MRF is estimated to cost around USD 23 million internationally. For five regional facilities, this results in a financing requirement of around MYR 518 million.[113]

- Scenario 1: PAYT
  A fee model that links waste fees directly to the amount of residual waste encourages separate collection and reduces residual waste volumes by 15–30%.[90] Applied to Malaysia, with a residual household waste volume of around 5.58 million tons and a fee of MYR 300 per ton, this would generate revenues of around MYR 1.17–1.42 billion per year. This would almost cover operating costs, but not investments in infrastructure. At the same time, the model requires social compensation mechanisms to relieve low-income households.

- Scenario 2: Combination of EPR and PAYT
  Extended producer responsibility supplements PAYT with a fund into which manufacturers pay according to the amount of material used. Malaysia is currently preparing an EPR law for packaging.[113] International experience shows that EPR systems increase recycling rates and promote eco-friendly product design.[71] Based on conservative assumptions – 1.41 million tons of plastic packaging per year (PET, HDPE, LDPE, PP), 0.8 million tons of paper packaging, 0.1 million tons of metal packaging, and levies of MYR 500/t (plastic) and MYR 250/t (paper/metal), this would generate revenues of around MYR 930 million annually.[114] Together with PAYT revenues of MYR 1.34 billion, this results in a total volume of approximately MYR 2.27 billion per year. This could finance both operating costs and investments, while at the same time providing incentives at the producer and household level.

- Scenario 3: Combination of EPR and selective tax surcharges (SST+)
  A selective surcharge on the Sales and Services Tax (SST), which will be adjusted and extended to 5–10% from July 2025, could be applied to short-lived consumer goods.[115] A 1% tax on a market volume of around MYR 60 billion (conservative assumption based on retail data: MYR 143.9 billion in December 2023 alone for the total market) would generate additional revenue of MYR 600 million per year. Combined with EPR funds of MYR 930 million, this would generate an annual revenue stream of MYR 1.53 billion. This would cover operating costs, but only partially cover the necessary investments. From a social policy perspective, compensatory measures would be necessary to cushion the regressive impact.

The evaluation of the scenarios shows that PAYT alone generates substantial revenues and promotes separation, but is not sufficient to cover investments in modern recycling facilities. EPR in combination with PAYT provides the most balanced approach, as both producers and households are held accountable and sufficient funds are available for operations and investments. The combination of EPR with selective tax surcharges offers a high degree of administrative feasibility, but requires accompanying social measures.

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