A STUDY ON PRACTICES OF SOLID WASTE DISPOSAL IN DIFFERENT COUNTRIES

DEBBIE ANNABELLE ANGELINE

UNIVERSITI SAINS MALAYSIA

A STUDY ON PRACTICES OF SOLID WASTE DISPOSAL IN DIFFERENT COUNTRIES

by

DEBBIE ANNABELLE ANGELINE

This dissertation is submitted to

UNIVERSITI SAINS MALAYSIA

As partial fulfilment of the requirement for the degree of

BACHELOR OF ENGINEERING (HONS.)
(CIVIL ENGINEERING)

School of Civil Engineering
Universiti Sains Malaysia

October 2021

UNIVERSITI SAINS MALAYSIA

SCHOOL OF CIVIL ENGINEERING ACADEMIC SESSION 2020/2021

FINAL YEAR PROJECT EAA492/6
DISSERTATION ENDORSEMENT FORM

Title: A Study on Practices of Solid Waste Disposal in Different Countries

Name of Student: Debbie Annabelle Angeline

I hereby declare that all corrections and comments made by the supervisor(s)and examiner have been taken into consideration and rectified accordingly.

Signature:

Date: 6th August2021

Endorsed by:

DR. MUHD HARRIS RAMI
Pensyarah Kanan
Pusat Pengajian Kejuruteraan Aw
Universiti Sains Malaysia
Email: cemhr@usm.my

(Signature of Supervisor)

Name of Supervisor: Dr. Muhd Harris Ram1

Date: 6 August 2021

Approved by:

PROF DR MOHD SUFFIAN BIN YUSOFF
Pusat Pengajian Kejuruteraan Awam
Universiti Sains Malaysia, Kampus Kejuruteraan
14300, Nibong Tebal, Pulau Pinang
Tel: 04-5996223; Fax: 04-5996906
Email: cesuffian@usm.my

(Signature of Examiner)

Name of Examiner:

Date: 6.8.2021

(Important Note: This form can only be forwarded to examiners for his/her approval after endorsement has been obtained from supervisor)

ACKNOWLEDGEMENTS

To begin, I would like to express my gratitude to God and His blessings for providing me with the opportunity to successfully finish this study within the allotted time. Thus, I would want to show my gratitude to many people that assisted me tremendously during the process of preparing my thesis. Furthermore, I would like to convey my heartfelt appreciation to my supervisor, Dr. Muhd Harris Ramli, for his invaluable advice and assistance during this project. He has been an excellent instructor, and I hope we can collaborate again in the future. My sincere appreciation to my friends for their unwavering support, and, finally, to my parents for inspiring and motivating me to finish my study.

ABSTRAK

Pembandaran dan peningkatan penduduk telah menyebabkan peningkatan pengeluaran sisa pepejal. Ini memberi kesan yang besar terhadap masalah alam sekitar dan pertumbuhan ekonomi. Oleh itu, objektif penyelidikan ini adalah untuk menentukan taburan sisa pepejal di negara yang berbeza dan membandingkan kaedah pembuangan sisa pepejal mereka. Selain itu, kelebihan dan kekurangan dari pelbagai kaedah pelupusan sisa pepejal akan dinilai. Kajian ini menggunakan penilaian kritis literatur, di mana data dikumpulkan dari sumber sekunder seperti buku, jurnal, dan majalah. Langkah pertama penyelidikan adalah merancang, yang memerlukan penentuan masalah, ruang lingkup kajian, dan tujuan penyelidikan. Langkah kedua adalah menjalankan kajian, dan tahap terakhir adalah pendokumentasian hasil-hasil kajian. Hasil kajian ini menunjukkan bahawa Jepun, Singapura, dan Korea Selatan mempunyai dasar pengurusan sampah yang komprehensif yang memberi tumpuan pada pengurangan sampah di sumber, pengasingan sampah, dan kitar semula sampah. Akibatnya, negara-negara ini memiliki kadar kitar semula yang tinggi, yang mengakibatkan penurunan besar jumlah sisa pepejal yang dibuang semasa proses pelupusan terakhir. Selain itu, negara-negara ini sangat bergantung pada pembakaran sebagai kaedah pelupusan terakhir untuk meminimumkan jumlah sampah dan memaksimumkan penggunaan teknologi tenaga. Malaysia, Vietnam, dan India, sebaliknya, tidak melakukan pengurangan sampah di sumbernya, mengakibatkan sejumlah besar sampah dibuang di tempat pembuangan sampah. Dalam konteks kelestarian alam sekitar dan usaha untuk mengurangkan pengeluaran sisa pepejal, sangat penting untuk mengembangkan sistem yang dapat secara mengurangkan pengeluaran sampah dan meningkatkan kadar kitar semula. Jepun, Korea Selatan, dan Singapura secara efektif telah mengembangkan dan menguruskan sistem pembuangan sisa pepejal dan sampah mereka dalam hal ini.

ABSTRACT

Urbanization and population growth have increased the production of solid waste (SW). This has had a significant impact on environmental concerns and economic growth. Thus, the objectives of this research are to determine the distribution of SW in different countries and to compare their SW disposal methods. Additionally, the relative merits and demerits of various SW disposal methods will be evaluated. This study employs a critical evaluation of the literature, in which data are gathered from secondary sources such as books, journals, and periodicals. The first step of research is planning, which entails defining the issue, the scope of the study, and the research goals. The second step entails conducting the study, and the last stage entails documenting the findings. The findings of this research indicate that Japan, Singapore, and South Korea have comprehensive waste management policies that focus primarily on reducing waste at the source, waste segregation, and waste recycling. As a result, these countries have a high recycling rate, which has resulted in a substantial reduction in the amount of SW disposed of during the final disposal process. Additionally, these countries rely heavily on incineration as a final disposal method to minimize waste volume and maximize the usage of waste-to-energy technology. Malaysia, Vietnam, and India, on the other hand, do not conduct waste reduction at the source, resulting in a significant amount of waste being dumped in landfills. In the context of environmental sustainability and efforts to decrease SW production, it is critical to develop systems that effectively reduce waste creation and improve its recycling rate. Japan, South Korea, and Singapore have effectively developed and managed their SW disposal systems in this regard.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

SW	Solid Waste
SWM	Solid Waste Management
SDG	Sustainable Development Goals
WTE	Waste to Energy
MSW	Municipal Solid Waste

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Urbanization and population growth have increased environmental issues as a result of the increased production of solid waste (SW). The term "solid waste" refers to used and leftover materials such as household, industrial, and commercial garbage, as well as building and demolition garbage and marine garbage. These wastes come from a variety of sources, including residences, businesses, hotels, hospitals, and coastal zones. The demand to handle these solid wastes (SW) adequately and effectively has sparked tremendous attention over the years owing to concerns about the green environment, sustainability, and economic stability (Jama Farah, 2019).

Currently, municipal solid waste management is a growing problem in most countries due growth in urbanization and overall population. As noted by Singh (2019) the overall global population will rise from the current 7.6 billion to be between 9.5 billion and 10 billion by 2050. While in general an increase in population accelerates the production rate of solid waste, waste generation per capita becomes an issue when the rural population moves to urban centers (Tantanee & Hantrakul, 2019). Specifically, Tantanee and Hantrakul (2019) estimate that about 1,300,000, 000 tonnes of municipality solid waste (MSW) is generated around the world each year. The annual rate is expected to rise to 2,200,000, 000 tonnes by 2025.

Countries and municipals around the world have instituted measures to enhance their MSW management. However, current management practice still poses significant challenges, especially in low-income countries (Singh, 2019; Bundhoo, 2018). As indicated by Bundhoo

(2018) waste collection in the least developed countries is low and irregular causing people to resort to unhealthy practices, such as burning of wastes and illegal dumping. Singh (2019) supports these sentiments by arguing that waste management practices in low income suffer from uncertainty issues associated with treatment costs, disposal facility, and waste production. In other words, the waste management practices in such countries are ineffecient. Over 3 billion people around the world still do not have access to access to effective waste disposable mechanism (Iyamu et al., 2020).

Inefficient waste management practices leads to a wide variety of problems. For instance, dispossing through biomass burning leads to the emission of green house gasses into the atmosphere. Poor management and disposal mechanism can also increase the rate of pathogen production, water contamination, general enviromental degradation, and undermine socio-economic development (Singh, 2019; Iyamu et al., 2019). Therefore, It is critical to have information about the characteristics of solid waste when considering solid waste disposal methods. However, accurate statistics on the composition of solid waste are scarce and, when available, often out of date. Additionally, a more precise landfill categorization method is needed to account for data inconsistencies between sanitary landfills and waste dumps. Solid waste (SW) disposal procedures that are efficient are necessary to maintain a clean and healthy environment. Thus, effective solid waste (SW) management, collection, and disposal techniques must be implemented to address the problem of solid waste management.

1.2 Problem Statement

Over the last decades, solid waste (SW) has been generated in large quantities due to industrialization, rapid population, and economic expansion. Urbanization also has an effect on the total rate of solid waste generation in a number of both developed and developing countries. In many big cities, critical concerns regarding the collection, disposal, and dumping of solid waste (SW) remain unresolved. Increased generation of solid waste (SW) and disposal concerns have become more complicated as additional land is required for the final disposal of these solid wastes (Singh, 2019).

The major concerns related to the increasing production of solid waste (SW) are environmental degradation, social inclusion, and economic sustainability (Singh, 2019; Iyamu et al., 2019). Inefficient solid waste (SW) disposal methods have been linked to heavy metal contamination of bodies of water, open burning and pollution emission, and marine litter. Waste picking at open dump sites and waste collection sites for recycling has also presented a significant health danger to informal labourers. These environmental and health issues have resulted in a worldwide environmental crisis that requires a sustainable response. Additionally, a significant disparity in waste management methods between developing major cities and rural regions has exacerbated this problem. This disparity is mainly due to the quantity of solid waste (SW) produced and the availability of solid waste (SW) management facilities.

Rapid urbanisation and increasing population have also led to the disposal of more problematic non-degradable solid waster (Velvizhi, Shanthakumar, Das, Pugazhendi, Priya, Ashol & Karthic, 2020; Dwivedi, Mishra, Mondal, & Srivastava, 2019). Non-degradable polysters and synthetic materials have a wide variety of industrial use. They are used for

packing, developing toys, for electric insulinaton, medical, among others. Such use in industrial as well in consumer goods is resuting in high rise of non-degradable solid waste (Dwivedi et al., 2019). Storage and collection systems are growing increasingly complicated and expensive as types and sources of solid waste (SW) diversify and disposal locations become scarce within collecting zones (Velvizhi et al., 2020). Solid waste (SW) is composed of a range of components, the majority of which are non-biodegradable polymers and hazardous compounds created by industry. Similarly, the amount of hazardous waste created has grown significantly. This problem has prompted environmental concerns owing to soil contamination, leachate contamination of surface and groundwater, and greenhouse gas (GHG) emissions generated by waste decomposition.

Although it is widely accepted that waste management services are necessary components of any community, little is known about what constitutes effective solid waste (SW) disposal practices. Hence, present research attempts to investigate the solid waste disposal methods of various countries in order to assess the various disposal practices, their advantages and disadvantages, as well as how different countries handle solid waste distribution (SW). Therefore, research study with title "**A Study Practices of Solid Waste Disposal in Different Countries**" is proposed.

1.3 Objectives

The following are the research objectives:

1. To qualitatively review type of waste produced and disposed by different countries
2. To compare solid waste management practices of countries based on the income levels
3. To highlight elements of effective waste management practices that developing countries can adopt to enhance their waste management

1.4 Scope of Research

The scope of this research will focus on the waste disposal practices of different countries using data from previously published studies. The primary goal of waste disposal methods is to limit waste production, hence lowering disposal costs, decreasing environmental effects, and protecting human health. The conventional method of solid waste management employed in developing countries generates several issues, including inadequate collection coverage and irregular collection services, crude open dumping and burning without concern for environmental sustainability, and vermin and fly breeding (Samsudin & Don, 2013). Therefore, it is crucial to compare and assess the solid waste disposal practices from different countries and to investigate the advantages and disadvantages of these practices.

1.5 Dissertation Outline

The dissertation is made up of 5 chapters. The first chapters introduces the topic and justify why the topic should be pursued by providing background information and existing problem. The second chapter provides a brief analysis of work done by previous researchers. The third chapter highlights the methodology applied in this research. Fourth reviews and analyze the data, and the fifth provides recommendations and conclusions.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Chapter

This chapter gives an overview of solid waste (SW) and disposal procedures for solid waste (SW). Additionally, the environmental impacts of various solid waste (SW) disposal methods and sustainable waste management are also highlighted. The primary objective of this chapter is to give background information for this research by reviewing previously published studies.

2.2 Overview of Solid Waste

A waste is an undesirable or unneccessary by product of either direct or indirect human activity. Despite being undesirable and/or unneccessary, it unavoidable in most cases. Solid waste is therefore any waste produced by human or animal activity that is usually solid in form and is thrown as undesirable or unwanted (Chen, Bodirsky, Krueger, Mishra, & Popp, 2020). In this research, the term "solid waste" refers to both the heterogeneous bulk of urban throwaways and the more homogenous accumulation of agricultural, industrial, and mineral wastes. Additionally, rising production of solid waste is directly attributed by increasing consumption of residences, and insufficient garbage collection and disposal facilities and procedures (Singh, 2019; Iyamu et al., 2019).

As noted by Debrah, Vidal, and Dinis (2021), Waste management is a multifaceted issue. It is made up of socioeconomic, political, enviromental, and institutional elements. The multifacet nature of solid waste is highlighted by Nanda and Berruti (2020) who suggess that

composition and classification of solid wastes depends on the income level of a country. Neverthless, each country produces a combination of degradable and non-degrabable waste that if not managed properly can create myrid of issues. For that reason, SW should be disposed of efficiently and safely to safeguard the environment, human welfare, and natural resources.

Unsustainable SW disposal practices has both direct and indirect consequences. Direct effects are associated with economical consequences, ranging from material degradation and loss of aesthetic value to human health impairment, while indirect effects are associated with long-term consequences. This may involve upsetting the ecosystem's balance and structure, thus affecting its sustainability and socioeconomic well-being (Singh, 2019; Iyamu et al., 2019).

2.2.1 Composition of Solid Waste

It is critical to understand the amount and composition of generated SW to establish and design sustainable disposal practices for these materials. A sufficient understanding of the quantity and composition of SW will allow the treatment and eventual disposal of SW to be sustainable. Both the amount and content of waste vary considerably between days and seasons, and major variations exist not only between countries but also between adjacent areas and between income levels. Figure 1-1 highlights the global composition of waste products in terms of percentage.

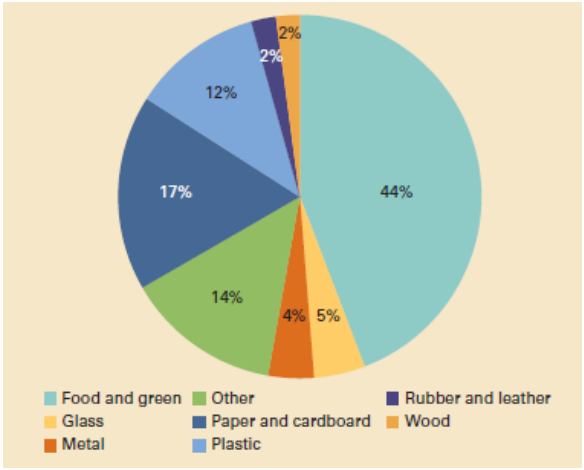

Figure 1 Global Waste Composition

According to Figure 1, food and green waste is the largest composition of food waste while rubber and wood make the lowest composition. Food and green still account for a large composition and percentage even comparison is made based on income levels of the countries (see figure 2)

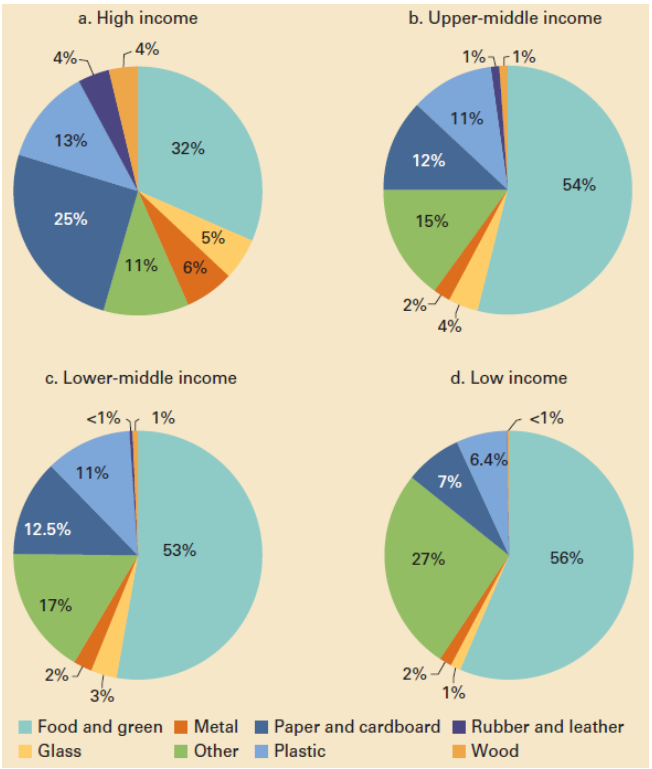

Figure 2 Global Waste Composition

A rise in population and urbanization is blamed for the rise in food and green-related waste. As noted by, Nanda and Berruti (2020), the consumption rates of even consumers in low-income countries have without a doubt increase, thus leading to high wastage. This view is supported by Andriani et al. (2017), who argued that SW generation is driven by demographic, behavioral, and economic variables and is fundamentally connected to urbanization and population increase.

Regardless of the amount of waste generated per capita, the primary problem is with the SW disposal plan and practises. At the present, there is a significant disparity between how developed and developing countries dispose of SW. Developed areas such as Europe and the United States of America have standardised waste management practices and established rules and regulations for various types of waste. However, landfilling is the main disposal practise in developing nations such as India and Thailand. This disparity in waste management practises is linked to a lack of awareness about solid waste management and its effects on the environment and human health, an inefficient collection system, a lack of waste management regulations, the absence of recycling alternatives, and a lack of infrastructure (Worldbank, 2018).

2.2.2 Waste Hierarchy Management

Sustainable solid waste management has attracted considerable attention in recent years as a result of growing concern about a healthy, green, and clean economy. To contribute to a sustainable environment, the first and most critical step is to reduce the source of SW, which may be accomplished via recycling and reusing wasted items. This is followed by methods for

removing SW, such as resource recovery, incineration, and landfilling. The waste hierarchy management system is shown in Figure 3.

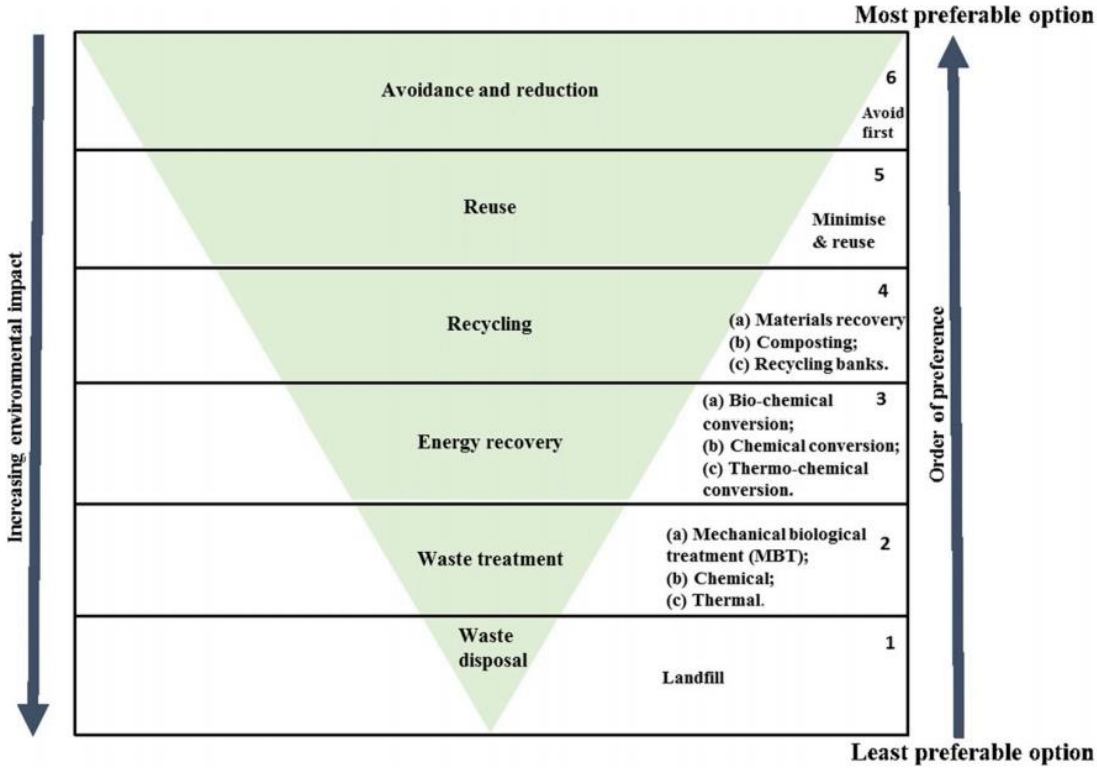

Figure 3 Waste management hierarchy

(Iyamu et a, 2020)

Avoidance and reduction refer to any action that contributes to waste reduction, toxicity reduction, and an emphasis on reuse and recycling at the source. Source reduction, as shown in Figure 2.2, is the ideal waste management approach since it eliminates the need for SW processing, transportation, and disposal. Source reduction entails modifying the design, manufacturing, packing, purchasing, and usage of goods or materials to decrease their toxicity

and waste generation at the source. As a result, source reduction is probably the most ecologically friendly method of reducing SW production.

Utilizing reusable products, purchasing products with less packaging, recycling and reusing products, purchasing non-hazardous products, and minimising product use are all effective source reduction strategies. These methods focus on protecting natural resources through manufacturing and developing efficient products, as well as minimising waste in proportion to the amount recovered, treated and disposed (Iyamu et a, 2020). Resource recovery incorporates the use of biochemical, chemical conversion, thermos-chemical conversion (Iya,I et al., 2020). According to waste hierarchy management, waste disposal is the least desired way of waste management when compared to source reduction.

2.3 Overview of Solid Waste Management Practices

Solid waste management practises encompass all actions aimed at mitigating adverse health, environmental, and economic consequences. Typical SW management procedures involve the collection, processing, and disposal of SW. Additionally, SW disposal procedures include the regulation of landfills, transfer stations, resource recovery facilities, incinerators, and related operations. SW disposal methods need the assessment and continuous development of these components in order to dispose of SW safely and correctly. The waste disposal practice adopted by a nation is highly dependended on its income (Iyamu et al., 2020). Developing nations have considerable difficulties in terms of SW collection, transportation, and disposal. As noted by Iyamu et al., (2020).

Typically, generated SW is disposed of in its entirety or undergoes intermediate treatment before final disposal. Intermediate treatments are intended to decrease waste volume, stabilise waste, and neutralise waste. Incineration is the most often used SW treatment method in developed countries. On the other hand, final disposal is the process of properly disposing of trash in an ecologically safe and sustainable way.Different practices are employed to handle solid waste, and the most suitable approach is decided by the properties of SW, the amount of accessible landfill, and the cost of disposal. The following practices are generally employed: recycling, composting, anaerobic digestion, thermo-chemical waste-to-energy (WTE) technologies such as incineration, gasification, and pyrolysis, and ultimate waste disposal such as landfilling are all popular waste management techniques.

However, final disposal is the least desirable form of waste management and is categorised generally as sanitary landfilling and open dumping. Sanitary landfilling is the process of disposing of wastes at an engineered disposal site, while open dumping is the uncontrolled disposal of wastes in unprotected disposal sites, which increases the danger of fires, groundwater pollution, and vector-borne disease transmission.

2.3.1 Final Solid Waste (SW) Disposal Practices

Landfilling, thermal waste treatment, anaerobic digestion, recycling, and aerobic composting are the top solid waste disposal practices (Iyamu et al., 2020). SW disposal practises are determined by the type of waste and the local environment. Composting is the process of converting organic waste into humus, which may be used as a soil amendment. Organic elements included in wastes initiate reaction with the assistance of microorganisms that have an adequate quantity of oxygen, resulting in the formation of heat and gas. Composting is one of the oldest and relatively safe solid wast disposal practices. It involves

using microorganism to control conversion degradable wast and products into stable materials that often used in gardening, landscaping, and agricultural products (Ayilara, Olanrewaju, Babalola, & Odeyemi, 2020).

Incineration is a thermal waste treatment process that utilises high-temperature burning to degrade organic materials and chemicals. The heat produced by the burning may be converted to power, which is referred to as waste-to-energy. The primary benefits of incineration are the substantial decrease in volume of SW and the production of energy from the burning heat.While incineration is considered an effective form of waste disposal, one of the primary disadvantages of this technique is its sustainability. Incineration produces hazardous fumes, liquid discharges, and different kinds of reductions that are either discharged into the environment or deposited in landfills (Samori et al., 2018).

A landfill is an area of land where waste is dumped. In general, landfills are divided into three types: open dumps, semi-controlled dumps, and sanitary landfills. Open dumps are uncontrolled low-lying regions or natural places. As a result, no suitable procedures for controlled disposal, leachate collection, or gas emissions have been implemented. SW is crushed and buried with topsoil in semi-controlled landfills. As with open dumps, this kind of landfill lacks collecting mechanisms for leachate and gas emissions. In developed countries, sanitary landfills, or modern landfills, are the norm. Sanitary landfills are well-engineered sites that adhere to established standards on their location, design, operation, monitoring, and

control. The collection of leachate and the release of gases are adequately controlled, with provisions for leachate treatment and usage (Maheshwari & Deswal, 2017).

2.3.2 Challenges of Solid Waste (SW) Disposal Practices

SW disposal practises are a multidisciplinary endeavour requiring knowledge of engineering, economics, and urban and regional planning (Debrah et al., 2021). Financial constraints, a lack of technical knowledge and access to equipment, a lack of technical expertise, insufficient government coordination, and a lack of planning are all common challenges associated with waste disposal practices, particurlaly in developed countries (Bundhoo, 2018). Many developing countries lack the capacity to fund infrastructure or operations sustainably. Often, countries are responsible for implementation but lack the financial resources or financial expertise necessary to deal with investment costs, facility maintenance, establishing a sufficient budget for solid waste projects, or rising costs and insufficient revenue as waste volume continues to grow.

Additionally, solid waste requires specialized equipment, which operators may lack the technical know-how or resources to properly maintain the equipment. If the technology is not intended to operate in the local environment, the incompatibility may aggravate existing issues by requiring repeated repairs. Local conditions such as humidity and heat can have a detrimental effect on equipment in tropical areas, necessitating frequent repairs. Also, local governments frequently lack the expertise necessary to evaluate technologies or solutions to determine which ones are the most appropriate for their circumstances. Difficult situations can arise when private companies enter contracts with the government to provide technology or to

implement a project but then abandon the project if the other party fails to meet the term of the contract (Nanda & Berruti, 2020).

Inadequate planning and evaluation at both the national and municipal levels can jeopardize the success of solid waste disposal practices. Mohammadi, Jämsä-Jounela and Harjunkoski (2018) that solid waste management should be considered as a strategic problem for it to be effectively managed. Adopting strategic thinking when engaging in solid waste management will not only optimize the entire process but can actually result in major cost reduction. That is precisely why national frameworks or regulations are critical to facilitating long-term planning, establishing national standards, and incentivizing waste reduction, recycling, and composting programmes. Planning at the municipal level, where implementation takes place, is frequently overlooked, which creates complications later. This is particularly true when unplanned disruptions occur, such as natural disasters.

SW disposal practises may be constrained by technical limitations such as the production of SW and its composition, the features of the region, haul lengths from the collection location to the disposal site, and operating expenses. In a larger context, SW disposal practises may be influenced by economic circumstances, labour and capital costs, equipment maintenance, and the availability of required treatment facilities. As a result, there is no one-size-fits-all strategy to SW disposal practises. Therefore, developed SW disposal practises should be tailored to the particular society and environment.

2.3.3 Issues associated with Solid Waste (SW) Disposal Practices

SW may contribute to environmental degradation through contamination of the air, water, and land, as a result of poor handling and unsustainable disposal practises. Inefficient SW disposal practices can have serious negative environmental consequences such as infectious diseases, land and water pollution, drain obstruction, and biodiversity loss. Inadequate SW disposal and management results in pollution of all types: air, soil, and water. Wastes dumped indiscriminately contaminate surface and ground water supplies. SW clogs drain in urban areas, resulting in stagnant water for insect breeding and flooding during rainy seasons. Uncontrolled solid waste burning, and improper incineration significantly contribute to urban air pollution (Keerti, 2017).

Greenhouse gases are produced when organic wastes decompose in landfills, and untreated leachate pollutes the surrounding soil and water bodies. Improper SW disposal practices also pose health and safety risks. Attracting insect and rodent vectors, waste can spread diseases such as cholera and dengue fever. Individuals can also be exposed to disease organisms and other contaminants when bathing, irrigating food, or drinking water that has been contaminated by solid waste (Singh, 2019).

Additionally, those living near or on the site are often exposed to pollution directly from hand to mouth and via inhalation of hazardous volatile chemicals and aerosols. Additionally, there is a direct physical risk associated with the possibility of waste landslides, collapsing landfills, explosions, fires, and waste-related transportation accidents. Improper SW disposal practices may pose hazards to the environment and public health. Direct health hazards are a problem mainly for employees in this sector, who must be kept as far away from wastes as

practicable. Additionally, there are hazards connected with hospital and clinic waste management. The main hazards to public health are indirect and arise as a result of the proliferation of disease vectors, particularly flies and rodents (Maheshwari & Deswal, 2017)

CHAPTER 3

METHODOLOGY

3.1 Introduction

The research methodology applied in this research is a critical literature review with a heavy reliance on secondary sources. The purpose of this study is to examine the primary solid waste (SW) methods used by various nations in the context of waste treatment and ultimate disposal.The findings and conclusions of this study will be derived from literature from the past 5 years, which will be analysed via the use of chosen publications and articles. This study used data from book chapters, journal articles, government reports, and unpublished publications. This research methodology consists of three stages: planning, conducting, and documenting the review. The methodology outline is summarized in Figure 4.

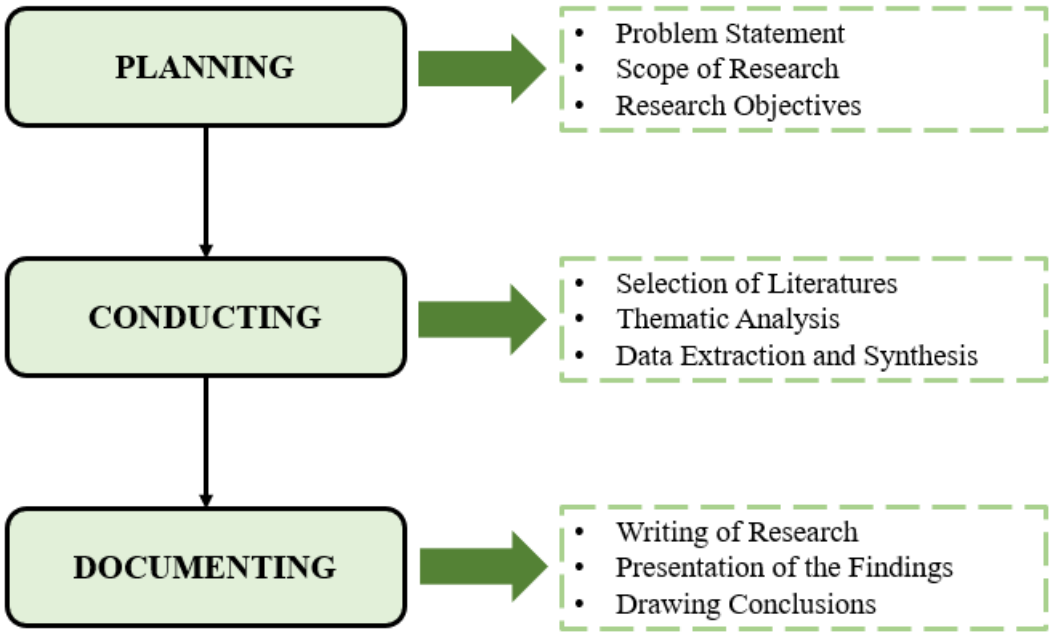

Figure 4 Methodology outline

3.2 Planning the Review

The initial step of this critical literature review is planning, which includes establishing the problem statement and the scope of the research. Identification of problems associated with solid waste (SW) disposal practices were identified in response to worldwide environmental concerns over unsustainable waste management practises and unreliable solid waste (SW) disposal practises. Within this context, the scope of this study will primarily focus on the solid waste (SW) disposal methods and distribution patterns of various nations. Additionally, the benefits and drawbacks of these practises will be evaluated in relation to solid waste (SW) collection, treatment, and disposal.

Following that, research objectives are defined. It is critical to define the scope of the study in order to meet the research objectives via an analysis of prior literature. The research objectives are then established in accordancewith the problem statement and research scope. The next phases of this research will try to meet the research goals within the scope of the study.

3.3 Conducting the Review

The second stage of this research is to perform a review, which entails going through the scientific literature, which is mostly comprised of journal articles, books, and government reports, with secondary reliance on unpublished works and websites. The main aim of this study is to evaluate SW disposal practices of different countries and to assess their SW distribution. This will enable discussion of the benefits and drawbacks of implementation of SW disposal practices of different countries. Several research questions (RQ) were derived from these objectives as a guide for the analysis:

RQ1: What are the SW disposal practices in different countries?

RQ2: What methods are used to gather, transfer, and transport SW?

RQ3: What are the primary methods for treating and disposing of SW?

RQ4: What are the benefits and disadvantages of different of SW disposal practices?

RQ5: Is the present SW disposal practices sustainable?

RQ6: What are the possible factors that affecting SW generation?

Following the development of the research questions (RQ), the research protocol was established based on two pillars: (1) criteria on the composition and construction of articles, such as publication year, country, language, title, abstract, and keywords; and (2) perspectives on the basis of SW disposal practises, such as generation, composition, storage, collection, transfer, and translocation.

The primary keywords used to review the articles are those relating to solid waste (SW) disposal practises in various countries, thus combining the terms "solid waste" and "disposal practises" with the following: different countries, environmental pollution, sustainable solid waste management, landfill reclamation, sustainable development, and solid waste distribution. The method of identifying and screening suitable sources for evaluation was based on source identification, screening, and eligibility. The review of the literature took place between February and May 2021, with only articles published between 2016 and 2021 being included in the review.

The findings of this study will focus on answering these research questions and meeting the research objectives. Following that, data analysis was performed on the articles in order to evaluate and compare the findings. A standardised data extraction table was used to extract the

necessary data in order to make meaningful findings. Thematic analysis is primarily used in this study to analyse common themes and patterns associated with solid waste (SW) disposal methods.

3.4 Documenting the Review

Documentation of the review entails writing the research, which presentation of the findings, and making critical conclusions. Tables with summaries of the articles were generated to provide data on SW disposal practises in different countries. The general perspective enables the sharing of expertise and SW disposal practice in different countries, to identify areas for improvement. As such,, the study attempted to evaluate SW disposal practices by analysing the pillar of perspectives defined in the second stage. This section also makes an effort to answer the research questions and address the research objectives.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Solid waste (SW) disposal methods continue to be a critical problem that must be addressed worldwide in order to create a sustainable environment. The environment, resource scarcity, public health, and public knowledge are the primary variables influencing SW disposal methods. As a result, disposal methods should be adapted to the composition and quantity of produced SW. Based on the properties of SW, it is possible to develop and choose SW collecting equipment that is suitable for the local environment.

SW disposal practises varying significantly between areas and countries. Government laws and regulations, enforcement of effective SW disposal methods, financial support, and the type and quantity of waste produced all contribute to this variation. Solid waste (SW) disposal procedures refer to the actions involved in regulating the production, storage, collection, transport and transfer, processing, and disposal of SW. In terms of waste hierarchy management, the most desired approach is waste prevention at the source, followed by reuse, recycling, and composting. After that, waste disposal is addressed, which includes resource recovery, incineration, and landfilling(Ziraba et al., 2016).

The findings are organised around addressing the research objectives by responding to the research questions. Therefore,the research findings are split into three sections: solid waste (SW) disposal, SW distribution, and the benefits and drawbacks of SW disposal methods adopted in different countries.

4.2 Distribution of Solid Waste (SW)

The quantity of produced SW has risen dramatically, owing mostly to rising living standards, fast technological advancements, economic expansion, and population boom. SW disposal methods are a worldwide problem and a significant challenge, with the potential for severe environmental effects if sustainable practises are neglected.

4.2.1 Solid Waste (SW) Disposal Method based on income and region

Solid waste (SW) disposal and treatment can vary widely all across the world, particularly depending on the income levels of the country in question. The SW method used across the world are open dump, landfill, composting and incineration. Figure 5 provide latest world bank research and projection that show wast management practices based on income and regional levels measures.

\