JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT

ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4

PAGES 170 - 187

Predicting Municipal Solid Waste (MSW) Disposal Site Using Multiple-Criteria Decision Analysis (MCDA)

Taiwo J. Oluboyede
Department of Surveying & Geoinformatics
The Federal Polytechnic Ado-Ekiti

oluboyede_tj@fedpolyado.edu.ng

ABSTRACT
This research is concerned with predicting municipal solid waste landfill sites using multicriteria analysis in Ado Ekiti and provides an overview of the study conducted to identify suitable locations for municipal solid waste landfills in the area. It describes the methodology employed, data, and results obtained. It highlights the key criteria considered in the analysis, such as Built-up Area and hydrogeological conditions, land use, land cover, transportation infrastructure, and environmental impact, among others. It also describes the multi-criteria analysis approach used, such as the weights assigned to each criterion and the decision rules applied. Furthermore, the abstract presents the results of landfill site prediction, showcasing the mapped areas with varying degrees of suitability for municipal solid waste landfills in Ado Ekiti. This demonstrates how the multi-criteria analysis approach helps in identifying the most critical areas that require immediate attention and resources for landfill site selection. They also discuss the implications of the findings for waste management planning and policy decisions in Ado Ekiti, highlighting the importance of this study to inform the selection of suitable landfill sites and the development of sustainable waste management strategies. Overall, the abstract on predicting municipal solid waste landfill sites using multi-criteria analysis in Ado Ekiti provides a comprehensive summary of the research conducted, highlighting the significance of the approach in waste management planning and its potential applications in landfill site selection in the area.

Keywords: Municipal Solid Waste; Multiple-Criteria Decision Analysis; Geospatial Technologies, Analytical Hierarchical Analysis; Ado-Ekiti

Introduction

In recent decades, escalating global population coupled with rapid urbanization has led to an exponential increase in the generation of Municipal Solid Waste (MSW) (Zhao et al., 2024). MSW management has become a pressing issue for policymakers, urban planners, and environmentalists worldwide (Vergara and Tchobanoglous, 2012b). Inefficient waste management practices pose significant environmental and public health risks, strain economic resources, and exacerbate social inequalities (Godfrey et al., 2019). Addressing these challenges requires innovative approaches that can anticipate future waste generation trends and effectively optimize waste management strategies. MSW management presents multifaceted challenges that transcend geographical boundaries and socioeconomic contexts. With urban populations projected to reach unprecedented levels in the coming decades, the volume of waste generated is expected to exponentially increase (Lebreton & Andrady, 2019). Improper disposal of MSW leads to environmental degradation,

ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4

PAGES 170 - 187

contamination of water bodies, emission of greenhouse gases (GHGs), and depletion of natural resources. Moreover, inadequate waste management infrastructure often disproportionately affects marginalized communities, exacerbating social disparities. Historically, MSW management has relied on linear models or single-criteria approaches, which often overlook the complexity and interconnectedness of waste management systems (Beaudry & Blankenship, 1996). Such approaches fail to account for the diverse array of factors that influence waste generation, collection, treatment, and disposal. Additionally, they may not adequately capture the trade-offs among economic efficiency, environmental sustainability, and social equity.

Rapid population growth, economic development, and industrialization have created many problems related to municipal solid waste management (MSWM) in developing countries such as Nigeria (Yildirim et al., 2018). Solid waste management is an established challenge in Nigeria as a whole, and in Ekiti. A report in 2022 by UNIDO indicated that Nigeria generates 32 million tons of solid waste, of which 2.5 million is plastic waste.1 The waste generation rate varies from 0.13 kg – 0.95 kg per capita per day between rural and urban settlements, which is expected to increase significantly because of the rapidly growing population of the state. The volume of municipal waste generated in Ekiti State is currently unknown; however, given the projected population of the state and the average waste generated per capita, the amount of waste generated in the state may be up to 2,900 tons per day. The municipal waste management sector in Ekiti remains largely ineffective, with solid waste collection estimated to be less than 5% across the state. Consequently, municipal waste is disposed of through burning in backyard compounds, open dumping (IBIMILUA & OMIDIJI, 2024), or disposal in canals and channels, leading to drainage blockages and damage to critical infrastructure, such as bridges and culverts. This study seeks to address the need for a municipal waste disposal site for Ado-Ekiti using Multi-Criteria Decision Analysis (MCDA).

Solid waste management poses a significant challenge across Nigeria, particularly in Ekiti State. A 2022 report by UNIDO revealed that Nigeria generates 32 million tons of solid waste annually, with 2.5 million tons of plastic waste. The rate of waste generation varies between rural and urban areas, ranging from 0.13 kg to 0.95 kg per capita per day, and is expected to increase due to population growth. While the exact volume of municipal waste in Ekiti State is unknown, projections suggest that it could reach up to 2,900 tons per day, given the state's population size and average waste generation per capita. Poor management practices have detrimental effects on public health, the environment, and livelihoods, including increased flood risks, infrastructure destruction, habitat degradation, and heightened health risks for waste workers. Despite efforts

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

by the Ekiti State Government, significant gaps persist, hindering the development of an effective solid waste management system. These gaps include a lack of reliable data on waste volume, sources, recycling rates, and disposal methods; the absence of defined policies guiding waste management; inadequate infrastructure, such as insufficient collection vehicles and equipment; and the absence of landfill facilities.To address these challenges, the Ekiti State Government passed the Ekiti State Waste Management Law in 2020 and invested in upgrading waste management equipment, including purchasing compactors, roll-on, roll-off trucks, and dino bins. However, further action is needed to bridge the existing gaps, including prioritizing data collection, developing comprehensive waste management policies, and investing in infrastructure improvements. Additionally, collaboration between government agencies, private sector stakeholders, and communities is essential for implementing sustainable solutions and effectively managing solid waste in Ekiti State. (https://www.unido.org/sites/default/files/unido-publications/2022-12/Plastic-value-chain-in-Nigeria.pdf).

In Ekiti State, the management of solid waste poses multifaceted challenges, ranging from inadequate collection and disposal systems to insufficient recycling and treatment facilities (Onibokun 1999). This situation exacerbates environmental pollution and poses significant risks to public health and safety (Manisalidis et al., 2020). Moreover, improper solid waste management practices, such as open dumping and burning, contribute to the degradation of land, air, and water resources (Abubakar et al., 2022), further compounding the environmental and health hazards faced by communities in Ekiti (Abolayo, 2019). Given these complexities, there is an urgent need for a comprehensive understanding and effective intervention to address the solid waste crisis in Ekiti State (ADEROGBA, 2014). Collaborative efforts among government agencies, local authorities, communities (Agranoff & McGuire, 2003), and other stakeholders are required to develop sustainable waste management strategies tailored to the unique needs and challenges of the state (Joseph, 2006). By prioritizing the management of solid waste, Ekiti State can mitigate environmental degradation, protect public health, and foster a cleaner and healthier living environment for its residents (Ibimilua and Ayiti, n.d.). In summary, the study of solid waste in Ekiti State is not only justified, but also imperative for addressing pressing environmental, social, economic, and public health challenges (Abolayo, 2019). Through comprehensive research and collaborative efforts, stakeholders can develop and implement holistic solutions that promote sustainable development and improve the quality of life of residents of Ekiti State (Banso et al., 2023). Municipal solid waste landfill sites include site selection, waste acceptance criteria, handling and compaction, operation and monitoring, environmental compliance, community engagement and innovation. By addressing these aspects, landfill sites can effectively manage waste while minimizing environmental impact and protecting public health.

JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

This study aims to predict the Municipal Solid Waste (MSW) landfill site for Ado-Ekiti using multi-criteria analysis. The research will use GIS-based analysis by combining criteria maps using weighted layer combinations to generate a landfill suitability map indicating potential sites in the study area (Ado-Ekiti).

Understanding the solid waste situation in Ekiti State is crucial because of its multifaceted impact on the environment, public health, infrastructure, economy, and society (IBIMILUA & OMIDIJI, 2024). Proper waste management is necessary to mitigate environmental degradation, prevent public health hazards, preserve critical infrastructure, promote resource recovery and recycling, and address socioeconomic inequalities (Sharma et al. 2021). By studying solid waste patterns and behaviors, policymakers can develop evidence-based strategies to improve waste management practices, promote sustainable development, and enhance the well-being of communities in Ekiti State (Malachi et al., 2023). Additionally, effective waste management contributes to the conservation of natural resources and reduces greenhouse gas emissions, thereby mitigating climate change impacts (Qambrani et al., 2017). Furthermore, addressing solid waste challenges fosters innovation and entrepreneurship opportunities in waste recovery and recycling industries, creates jobs, and stimulates economic growth (Elagroudy et al., 2016). Moreover, understanding the sociocultural aspects of waste generation and disposal practices is essential for designing culturally sensitive and community-driven waste management interventions (Ezeudu & Chukwudubem, 2023). By involving local communities in waste management initiatives, stakeholders can foster a sense of ownership and participation, leading to more sustainable and resilient waste management systems (Salsabila et al. 2024). Solid waste management has emerged as a pressing issue in Ekiti State, Nigeria, paralleling similar challenges across the country (Ayodeji and Ade-Ibijola 2022). The state faces a mounting problem with waste generation owing to factors such as rapid urbanization, population growth, and changing consumption patterns (Brown & Jacobson, 1987). As a result, inadequate infrastructure and resources for waste management struggle to keep pace with the escalating volume of waste (Onibokun, 1999).

Theoretical / Conceptual Framework

Solid waste can be categorized into urban hard waste, industrial solid waste, agricultural solid waste, and biological or hospital waste. Effective management involves waste reduction strategies based on four Rs: reducing, reusing, recycling, and recovering (Kubanza & Simatele, 2020). Waste is classified into hazardous

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

and nonhazardous types. Management includes composting, salvage, fermenting, incineration, open burning, marine dumping, and sanitary landfills, with a focus on reducing waste at the source in developed countries to minimize the environmental impact (Thamilmaraiselvi et al., 2024). Solid waste management encompasses municipal solid waste (MSW), organic waste, recyclables (paper, glass, and metals), and hazardous waste.

Management strategies include waste reduction, recycling, composting, incineration, and proper landfill disposal to minimize environmental impacts and promote resource recovery (Berry et al., 2025). Waste disposal refers to the process of collecting, treating, and disposing of solid, liquid, and hazardous waste. This is a critical aspect of both environmental and public health protection. SWM is a crucial issue for sustainable development, encompassing technological, social, legal, ecological, political, and cultural aspects. For decades, systems analysis has offered multidisciplinary assistance for policy analysis and decision making in solid waste management (Shukla et al., 2020). SWM continues to dominate as a major societal and governance challenge, especially in urban areas overwhelmed by high population growth rates and garbage generation. The role of SWM in achieving sustainable development has been emphasized in several international development agendas, charters, and visions. Sustained SWM can help meet several UN Sustainable Development Goals (SDG) such as ensuring clean water and sanitation (SDG6), creating sustainable cities and inclusive communities (SDG11), mitigating climate change (SDG13), protecting life on land (SDG15), and demonstrating sustainable consumption and production patterns (SDG12). According to Vergara and Tchobanoglous (2012), management practices for municipal solid waste differ across municipalities, cities, states, and countries. The basic stages of municipal solid management are as follows:

1. generation of wastes;
2. collection, handling, and transfer of waste; and
3. disposal, processing, and treatment of waste

Waste management encompasses the systematic collection, transportation, treatment, and disposal of various types of waste generated from human activities, including municipal, industrial, agricultural, and hazardous wastes. Solid waste can be categorized into urban hard waste, industrial solid waste, agricultural waste, and bio-hospital waste, with urban areas producing approximately 1.5 billion tons annually, which is projected to double by 2025 (Jana et al., 2025). Effective management strategies aim to minimize environmental pollution and public health risks by employing methods such as recycling, composting, and landfill management (Berry et al., 2025; Rajpoot, 2024). The rise of e-waste, characterized by discarded electronic devices, poses significant challenges owing to its hazardous components (Thamilmaraiselvi et al., 2024). Modern waste

ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4

PAGES 170 - 187

management increasingly incorporates technological advancements and sociological factors, promoting public awareness and the principles of reducing, reusing, recycling, and recovering waste (Berry et al., 2025; Rajpoot, 2024). Municipal Solid Waste (MSW) includes product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, and batteries. Effective management encompasses waste generation, collection, treatment, and landfilling, considering physical, chemical, and biological characteristics for optimal handling.

Multi-Criteria Decision Analysis (MCDA)

MCDA stands for Multi-Criteria Decision Analysis. It is a multi-criteria decision-making method that helps in structuring complex decisions. The MCDA provides a structured and logical approach to complex multi-criteria decision problems, helping to break down the problem, make pairwise comparisons (Özdağoğlu & Özdağoğlu, 2007), and arrive at a final prioritized set of alternatives. This is a valuable tool for supporting complex decision-making. The AHP method allows decision makers to incorporate both objective and subjective factors into the decision-making process. It is widely used in a variety of fields of strategic planning, resource allocation, project selection, performance evaluation, quality management, public policy, healthcare, education, and so on.

Key features of the Analytic Hierarchy Process (AHP) are:

1. Structuring a complex problem as a hierarchy, with the goal at the top, criteria, and sub-criteria at levels below, and decision alternatives at the bottom
2. Performing pairwise comparisons between elements at each level to determine their relative importance or priority.
3. Synthesizing the pairwise comparisons to obtain overall priorities for the decision alternatives.

Review of relevant literature

Rane et al., (2024) researched the landfill site selection in Ambernath and its environs, India. In this regard, twelve environmental, physical, and socio-economic factors have been considered to maintain sustainability and tackle the solid waste disposal problems. Integrated GIS (Karabulut et al., 2022) (Geographic Information System) based on the Multi-Influencing Factor (MIF) technique were adopted with an emphasis on structuring the decision-making processes to locate appropriate landfill locations that are cost-effective, environmentally sustainable, and acceptable in a public context (Soltani et al., 2015).

JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

The coastal city of Visakhapatnam, also known as Vizag, produces a mass amount of solid waste due to tourism and industrial growth, posing a major threat to waste disposal and management. The (Chakraborty & Dolui, 2023)study was based on 14 influencing criteria as well as seven constraint criteria. Fuzzy Decision-Making Trial and Evaluation Laboratory (Fuzzy-DEMATEL) model was used to accomplish relative weights of criteria for disposal site selection.

Zhang et al., (2024) reviewed Machine Learning (ML) methods enable systems to learn data patterns and have various applications in Municipal Solid Waste Management (MSWM). This study examines how ML can enhance resource recovery in Latin America and the Caribbean (LA&C) and analyzes the opportunities and challenges in improving circularity in MSWM using ML. The methodology involved a systematic literature review using the PRISMA protocol on the Web of Science database from 2010 to 2021, along with bibliometric analysis using the Bibliophagy application. A total of 188 papers were reviewed.

Key challenges in advancing MSWM in LA&C include:

- Lack of reliable data on waste composition and production.
- Low rates of waste being used as resources.
- Need to change consumption patterns.
- Social inclusion of informal waste collectors.
- Incorporation of repair and reuse actions to reduce waste generation.

Africa has significantly increased municipal solid waste (MSW) generation. However, inadequate disposal strategies, limited land resources, financial constraints, and disorganized public behavior have hindered effective policy implementation and monitoring (Zhang et al., 2024). This review, based on insights from 170 academic papers from 2013 to 2023, examines the key challenges of MSW management in these regions. It advocates for waste sorting at the source, optimizing landfill practices, thermal treatment measures, and leveraging the value of waste as more suitable solutions than focusing solely on recycling (Munir et al., 2023). The review identifies socio-economic factors, infrastructural limitations, and cultural considerations as barriers to optimizing management systems (Ahmad et al., 2025). It emphasizes integrating the area into the circular economy framework, enhancing citizen participation in waste reduction, promoting recycling initiatives, and seeking economic support from international organizations (Klein et al., 2020).

Municipal solid waste management is a critical global issue, challenging city authorities worldwide. Kano metropolis, with a population exceeding four million, faces significant solid waste management problems similar to other major cities (Muhammad & Marzuki, 2024). This study evaluates the suitability of current

ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4

PAGES 170 - 187

solid waste disposal sites in metropolitan Kano (Umar & Naibbi, 2021). It utilizes satellite imagery (Landsat, AsterDEM), GPS coordinates of waste disposal sites, and a topographical map of Kano metropolis (Umar & Naibbi, 2021). These data were analyzed using a multi-criteria decision technique, producing restriction and suitability maps for waste disposal within the metropolis (Eghtesadifard et al., 2020). Results indicate that only 26% of the existing waste disposal sites are suitable, while 74% are unsuitable (Eghtesadifard et al., 2020). The study recommends relocating the unsuitable sites to more environmentally favorable locations identified in this study (Eck & Weisburd, 2015).

Giusti, 2009, examines the latest data on global waste generation and disposal methods, focusing on the European Union, OECD countries, China, and other developing nations. It also assesses the direct and indirect health impacts of waste management practices, with a primary focus on municipal solid waste. Additionally, it considers the effects of bioaerosols from composting facilities, pathogens from sewage treatment plants, and radioactive waste. While numerous studies have investigated the health effects on waste facility employees and nearby residents, the evidence for adverse health outcomes in the general population is often limited and inconclusive (Giusti, 2009). However, there is strong evidence linking sewage treatment plants to gastrointestinal problems (Ercumen et al., 2014). To enhance the quality of epidemiological studies in this field, future research should prioritize prospective cohort studies with robust statistical power, direct exposure measurements, and biomarker data (Pernot et al., 2012).

According to Mor & Ravindra, 2023, in lower- and middle-income countries, municipal solid waste (MSW) management is often disorganized, leading to severe environmental and health consequences. Improper landfill disposal contaminates groundwater, soil, and air (Mor & Ravindra, 2023), causing numerous health hazards. In India, a staggering 79% of MSW remains unmanaged, with only 21% adequately processed. The unmanaged waste is disposed of in unhygienic landfills, contributing to significant greenhouse gas emissions, obnoxious odors, and fire hazards that adversely affect local ecosystems (Bansal et al., 2023). Landfills are a significant source of CH4 production, accounting for 29% of global GHG emissions, which is projected to increase to 64% and 76% by 2030 and 2050, respectively (Wang et al., 2024). Effective solid waste management practices, resource recovery, and waste-to-energy technologies are crucial to mitigate these issues (Kumar & Samadder, 2017). However, adequate financial and government support are necessary to execute these solutions. Secure waste disposal through engineered landfills and waste-to-energy plants, along with community awareness, education, and the adoption of emerging technologies (Yong et al., 2019), can significantly reduce the adverse effects of MSW disposal and contribute to achieving the United Nations' sustainable development goals (Pujara et al., 2019). Proper waste management requires local corporations to manage waste services effectively, following national-specific policies, standards, and guidelines (Antonioli & Massarutto, 2012).

Methodology

Description of the Study Area

Ado-Ekiti, town, capital of Ekiti state, southwestern Nigeria. It lies in the Yoruba Hills, The city is located within the North Western, part of the Benin-Owena River Basin Development Area. The city lies between Latitude7° 34' and 7° 44' north of the Equator and Longitude 5° 11' and 5° 18' east of the Greenwich Meridian Ado-Ekiti 2006 population census which put the population to 308,621. It is bounded on the North and West by Ifelodun/Irepodun Local Government and east and South by Aiyekire, Ikere and Ekiti South west local Government. Its longest North-south extent is 16km and the longest East-west stretch is about 20km. The area lies within the tropical climate with two distinct wet and dry seasons. The tropical continental (CT) airmass brings the dry weather, blowing in from the Sahara desert between November and March. The wet season comes either the tropical maritime (MT) air mass originating from the Atlantic Ocean between the months of April and October. The total rainfall in the area is 450mm, giving a mean monthly rainfall of 121mm. There is a sharp fall in rainfall between July and August (August Break). The region's temperature is high throughout the year, with a mean monthly temperature of 27C and a range of 3.7C between the month with the highest temperature (February) and the month with the lowest (August). The whole of the Local government is underlain by the basement complex with the major rocks identified as undifferentiated igneous and laterites and white sand which abound in the area. Also, there are minor deposits of gold and tin ore the mineral natural resources have neither been exploited. The region is endowed with forest resources of all sorts such as animal wildlife and hardwoods like Iroko, Obeche, Mahogany, and Afara. Apart from this, the federal and state governments have established forest reserves at various points in the region to balance the rate at which the forest resources and being depleted.

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

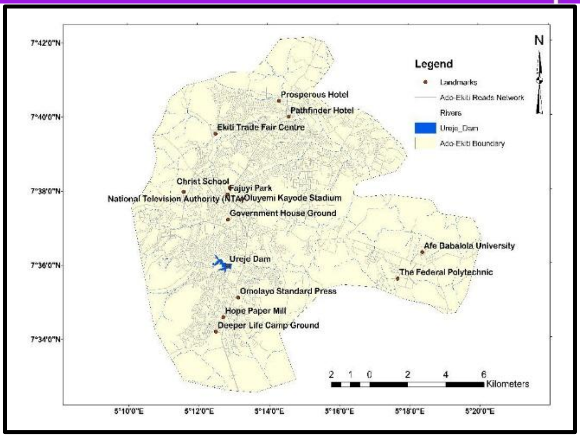


Figure ; Map of the Study Area

Materials and Methods

The process of choosing a landfill site is laborious and complex since many considerations must be taken into account. Due to its ability to handle large amounts of spatial data from multiple sources, the Multi-Criteria Technique based on Geographic Information Systems (GIS) is effective in these situations (Dar et al., 2018). The GIS-based analysis in this study is conducted using Esri ArcGIS 10.8 software. The program is used for basic tasks, including buffer, clip, intersect, union, merge, dissolve, identify, weighted overlay, and erase. The methodology used in the study involves the following steps

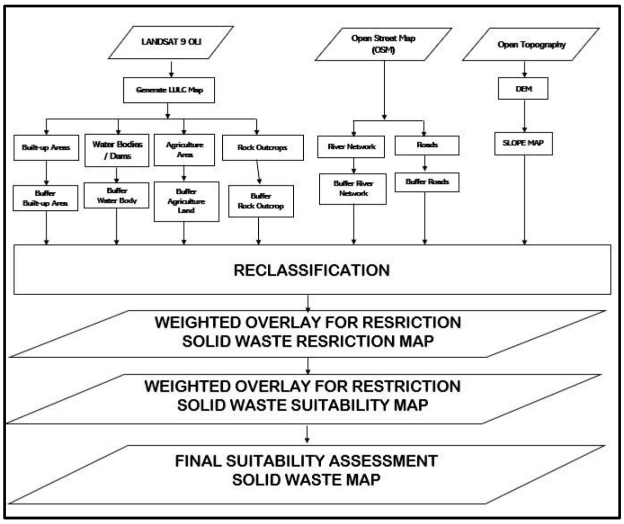


Figure 2: Flow chart of the methodology adopted

Materials (Data Sets)

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

The data used for analysis can be broadly categorized into two groups: primary data, consisting of raw data acquired from different agencies like the USGS Earth Explorer.

Table 1: Datasets description.

SN	Data Set	Source
1	LULC	Earth Explorer Landsat 9
2	SLOPE	DEM Open Topography
3	ROAD NETWORK	Open Street Map (OSM)
4	WATER BODIES /RIVERS NETWORK	Extract from LULC / OSM
5	BUILT-UP AREA	Extract from LULC

The first critical step was to identify the required set of standard criteria based on an in-depth literature review. The second crucial step required the establishment of various maps, including road networks, slopes, vegetation, soil type, land use, drainage patterns, in digital GIS format, and were projected to a common

projection. The digital elevation model (DEM) was downloaded from OpenTopography spatial resolution of 30 × 30 m. Landsat 08 OLI satellite images were downloaded from the United States Geological Survey (USGS) website (https:// earthexplorer.usgs.gov/) to generate a landuse map using ArcGIS 10.8 software. Urban areas, road networks, and land cover, were downloaded from online OpenStreetMap (OSM) data and processed by using ArcGIS Editor for OSM 10.8, a free add-in for ArcMap to produce the desired maps. All created maps were finally converted to a raster format. Essential areas such as airports, built-up areas, agricultural lands, and industrial zones were masked out for landfill site selection by buffering them at safe distances from the periphery or edges as suggested in the literature review (see Table-2), while roads, streams, were buffered on both sides using ArcGIS 10.8 software. In addition to complying with national and local regulations, establishing buffer zones is essential to protect human health and water resources from pollution. The buffer zones indicate that they should not be considered (avoided) when selecting landfill sites. The positive prospect in our research is that the groundwater table is very deep, which minimizes the negative effects of groundwater pollution by leachate infiltration and thus a map of the groundwater is not necessary. The last crucial step was the use of GIS and AHP-MCDA for the selection of suitable landfill sites. Fig. 2 shows the hierarchy of a structure in the AHP-MCDA model with three levels of decision options. The combined approach of GIS and AHP-MCDA GIS also finds use in the location of landfill for the disposal of solid waste. The AHP along with MCDM method that is commonly used with GIS in the landfill site selection. Many researchers have successfully applied the combined method of GIS and AHP-MCDA to identify potential landfill sites. The AHP-MCDA methodology is simple, accurate, and science based. GIS provides useful information using spatial and non-spatial data. Seven (7) criteria were retrieved from the literature

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

review for the selection of landfill sites. The DMs involved in this study have strong expertise in their background disciplines including ArcGIS software, civil and environmental engineering, and waste management. Using literature, it was observed that seven (7) criteria strongly influence the selection of solid waste landfills for the study area, these are, Built-up Areas, River Network, Slope, Agricultural Lands, Rock Outcrop, Water Body, and Road Networks. In the AHP-MCDA methodology, the criteria weight plays a crucial role in finding a solution to a given problem. Pairwise comparison was utilized to extract weight for each of the seven parameters based on their relative importance.

The process of selecting a landfill site involves considering a multitude of factors, rendering the decision-making process arduous and intricate. Geographic Information System (GIS) based Multi Criteria Technique has proven to be efficient under such circumstances due to its capability to manage extensive spatial data from various sources (Dar et al., 2018). In this study, Esri ArcGIS 10.8 software is utilized for GIS-based analysis. Basic tasks in the software, such as buffer, clip, intersect, union, merge, dissolve, identify, weighted overlay, and erase, are employed. Due to the efficiency of achieving greater validation and accuracy while saving time and money, the Multicriteria Decision Analysis (MCDA) approach and GIS-based models are becoming more and more popular as effective tools for ideal site selection for landfill (Özkan et al., 2019; Pande, 2020).

The weights for the various criteria are established through pairwise comparisons. Additionally, the Consistency Ratio (CR) can be determined for pairwise comparisons, which measures the consistency of judgments relative to extensive data samples. The CR value should ideally be equal to or less than 0.1 (10%) for the matrix to be considered consistent (Hecson and Macwan, 2017). Upon calculating the weights, data for the aforementioned parameters are acquired using the 'measure' tool, which is utilized to determine both lengths and areas. Data normalization is conducted to reduce redundancy and enhance data integrity by eliminating measurement units.

The Multi-Criteria Evaluation (MCE) technique is employed to identify the most feasible site among the potential locations. MCE offers a systematic, well-organized process for considering various factors, allowing for their clear identification and prioritization. It enables the ranking of alternative solutions based on their suitability (Chang et al., 2008). The site with the highest summation of weight multiplied by normalized parameter data along the column is deemed the most feasible site. This summation is termed the Land

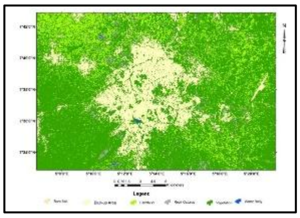
JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

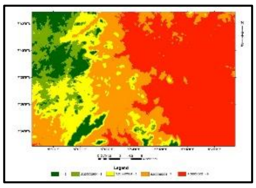
Suitability Index, denoted as LSI. Therefore, the candidate site with the highest LSI emerges as the most suitable site based on the social and biophysical environment of Ado-Ekiti.

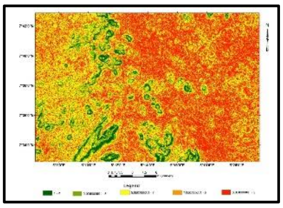
Table 2. Values considered for the Solid waste disposal site

i.	**Restriction values and weights**		
	Theme	**Buffer Type**	**Buffer Distance (m)**
	River Network	Single	500
	Road Network	Single	500
	Dam	Single	500
ii.	**Criteria for slope**		
	Slope	**Slope Range (in Degrees)**	**Weight**
	Flat	< 2°	5
	Gentle	2°–5°	4
	Moderately Steep	5°–10°	3
	Steep	10–15	2
	Very Steep	> 15°	1
iii.	**Criteria for Landuse Map**		
	Landuse Class	**Suitability**	**Weight**
	Built-up Area	Very Low	0
	Water Bodies /Dam	Very Low	0
	Rivers	Very Low	0
	Vegetation	Low	1
	Agricultural Land / Farm Land	Medium	2
	Bare Land / Bare Soil	High	3
iv.	**Suitability Values and Weights**		
	Theme	**Analysis**	**Weights (%)**
	Slope	Reclassification	50
	Landuse	Reclassification	50
	Rivers	Buffer & Reclassification	10
	Roads	Buffer & Reclassification	10

Modified after: UNEP/FAO (2019)


Landuse Map


Digital Elevation Model (DEM)


Slope Map

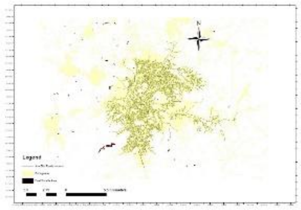

Road Network

Figure 3. Thematic layers used for the final production of Potential Sites

Extraction of Constrained Area and Identification of Potential Sites

Various criteria are utilized to assess areas that are restricted and therefore unsuitable for landfill siting. These criteria encompass roads, railway lines, airports, water bodies, agricultural and allied areas, residential areas, built-up areas, and their associated buffers. Geoprocessing tools are employed to construct the Restriction Map, aiding in the differentiation between areas conducive to landfill siting and those restricted from such use. Utilizing the 'Layers' system in ArcGIS software facilitates the management of different buffer polygons and features during analysis under various scenarios. Areas smaller than 5 hectares are disregarded, resulting in identifying a final solid waste disposal site, as shown in Figure 4.

JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

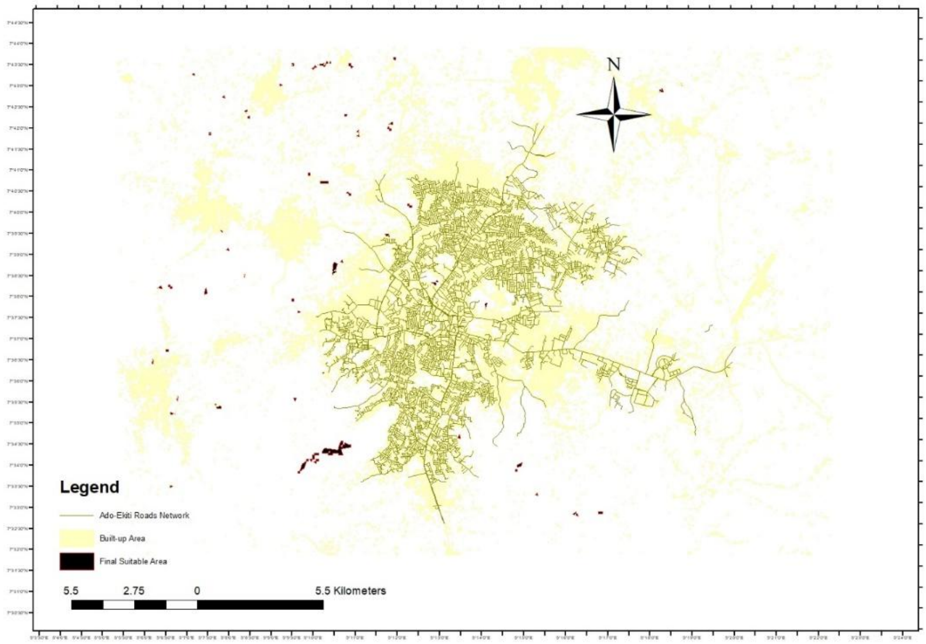


Figure 4: Map of the Final Site for Solid Waste Disposal

Conclusion

The summary on predicting municipal solid waste landfill sites using multicriteria analysis in Ado Ekiti provides a brief overview of the study conducted to identify suitable locations for municipal solid waste landfills in the area. It highlights the key criteria considered in the analysis, such as geological and hydrogeological conditions, land use and zoning regulations, transportation infrastructure, and environmental impact, among others. The summary describes the multicriteria analysis approach used, such as the weights assigned to each criterion and the decision rules applied. It also presents the results of the landfill site prediction, showcasing the mapped areas with varying degrees of suitability for municipal solid waste landfills in Ado Ekiti. The summary discusses the implications of the findings for waste management planning and policy decisions in Ado Ekiti, highlighting the importance of the study in informing the selection of suitable landfill sites and the development of sustainable waste management strategies. This study provides a comprehensive evaluation of the available sites for a landfill in Ekiti State using a multi-criteria approach. The analysis helps to identify the most suitable site for a landfill based on the developed criteria. The multi-criteria approach will allow for a thorough evaluation of each site, taking into account various factors such as geographical location, environmental impact, social factors, and economic considerations. By using a multi-criteria approach, the project provides a more holistic and robust evaluation of the available sites, which will ultimately lead to a more informed and effective decision-making process. The results of the project provide valuable insights into the strengths and weaknesses of each site, allowing policymakers and stakeholders to make informed decisions about the most suitable location for a landfill in Ekiti State. The decision-making tool developed during the project provides a clear and transparent method for evaluating each site, which will help to ensure that the selection process is fair and unbiased. Additionally, the project provides recommendations for future research and monitoring to ensure that the selected site continues to meet the evolving needs of the community and the environment. Overall, the research contributes to the development of sustainable and environmentally friendly waste management practices in Ekiti State, ultimately improving the quality of life for residents and promoting a cleaner and healthier environment.

Based on the results of the multi-criteria analysis, the project provides recommendations for the selection of a landfill site in Ekiti State. The recommendations will take into account the importance of each criterion and will be designed to ensure that the selected site meets the needs of the community and the environment. Some potential recommendations include prioritizing sites that have a minimal impact on the surrounding environment, including air and water quality, as well as wildlife and vegetation. Additionally, it is important to select a site that is located away from residential areas, schools, and other sensitive facilities to minimize potential health risks to the community. Accessibility for waste collection trucks and the availability of

transportation infrastructure should also be considered. It is crucial to ensure that the selected site has a sufficient capacity to meet the waste management needs of Ekiti State for the foreseeable future. Incorporating measures to minimize the potential for leachate and groundwater contamination, such as proper liners and collection systems, is essential. Developing a plan for the post-closure care and rehabilitation of the landfill site will ensure that it is properly closed and restored to a safe and aesthetically pleasing condition. Engaging with the local community and stakeholders to ensure that the selected site is well-received and that any potential concerns or issues are addressed is also important. By following these recommendations, this will help to ensure that the selected landfill site is safe, sustainable, and meets the needs of the community and the environment. The recommendations is based on the results of the multi-criteria analysis and will take into account the importance of each criterion, ultimately leading to a more informed and effective decision-making process.

References

Abolayo, T. T. (2019). *Comparative Analysis of Heavy Metals Presence in Soil and Water in Relation to Its Environs: A Case Study of Gbagede Dumpsite Area of Kwara State and Ilokun Dumpsite Area of Ekiti State*. Kwara State University (Nigeria).

Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., Al-Gehlani, W. A. G., & Alrawaf, T. I. (2022). Environmental sustainability impacts of solid waste

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187
management practices in the global South. *International Journal of Environmental Research and Public Health*, *19*(19), 12717.
ADEROGBA, K. A. (2014). *Government Activities and Psycho-Social Factors As Determinants of Solid Waste Management Behaviour in South Western …*. http://ir.library.ui.edu.ng/handle/123456789/3968%0Ahttp://ir.library.ui.edu.ng/bitstream/123456789/3968/1/ui_thesis_aderogba_government_2014.pdf
Agranoff, R., & McGuire, M. (2003). *Collaborative public management: New strategies for local governments*. Georgetown University Press.
Ahmad, M., Ali, A., & Hussain, H. (2025). Spatial Data Infrastructure for Effective Information Management: A Case Study of Pakistan. In *Essential Information Systems Service Management* (pp. 251–278). IGI Global.
Antonioli, B., & Massarutto, A. (2012). The municipal waste management sector in Europe: shifting boundaries between public service and the market. *Annals of Public and Cooperative Economics*, *83*(4), 505–532.
Ayodeji, B. L., & Ade-Ibijola, A. O. (2022). The United Nations women and gender equality in Nigeria. *African Journal of Stability & Development*, *14*(1&2), 137–168.
Bansal, R., Hans, M., & Bansal, E. (2023). Impact of Solid Waste Disposal on Inland Water Wetlands: Solid Waste Management. In *Handbook of Research on Safe Disposal Methods of Municipal Solid Wastes for a Sustainable Environment* (pp. 285–295). IGI Global.
Banso, A. A., Coker, J. O., Uzougbo, N. S., & Bakare, S. S. (2023). The nexus of law and sustainable development in South West Nigerian public policy: a review of multidisciplinary approaches in policy formation. *International Journal of Applied Research in Social Sciences*, *5*(8), 308–329.
Beaudry, R. M., & Blankenship, S. M. (1996). Determining Fruit Maturity in Research and Industry Applications. *HortScience*, *31*(4), 691b – 691.
Berry, K., Kumar, S., & Kaushik, R. (2025). Solid Waste Management in Rural Tourist Hubs. In *Solid Waste Management and Disposal Practices in Rural Tourism* (pp. 27–54). IGI Global.
Brown, L. R., & Jacobson, J. L. (1987). *The Future of Urbanization: Facing the Ecological and Economic Constraints. Worldwatch Paper 77*. ERIC.
Chakraborty, S., & Dolui, S. (2023). Mapping alternative solid waste disposal sites using fuzzy-DEMATEL method in coastal city of Visakhapatnam, Andhra Pradesh (India). In *Water, Land, and Forest Susceptibility and Sustainability, Volume 2* (pp. 215–260). Elsevier. https://doi.org/10.1016/B978-0-443-15847-6.00005-7
Eck, J., & Weisburd, D. L. (2015). Crime places in crime theory. *Crime and Place: Crime Prevention Studies*, *4*.
Eghtesadifard, M., Afkhami, P., & Bazyar, A. (2020). An integrated approach to the selection of municipal solid waste landfills through GIS, K-Means and multi-criteria decision analysis. *Environmental Research*, *185*, 109348.
Elagroudy, S., Warith, M. A., & El Zayat, M. (2016). *Municipal solid waste management and green economy*. Global Young Academy Berlin, Germany.
Ercumen, A., Gruber, J. S., & Colford Jr, J. M. (2014). Water distribution system deficiencies and gastrointestinal illness: a systematic review and meta-analysis. *Environmental Health Perspectives*, *122*(7), 651–660.
Ezeudu, T. S., & Chukwudubem, E. K. (2023). Exploring Socio-Cultural Factors in the Context of Urban Environmental Management in Nigeria. *International Journal of Research and Innovation in Social Science (IJRISS)*, *7*, 282–300.
Giusti, L. (2009). A review of waste management practices and their impact on human health. *Waste Management*, *29*(8), 2227–2239. https://doi.org/10.1016/j.wasman.2009.03.028
Godfrey, L., Ahmed, M. T., Gebremedhin, K. G., Katima, J. H. Y., Oelofse, S., Osibanjo, O., Richter, U. H., & Yonli, A. H. (2019). Solid waste management in Africa: Governance failure or development opportunity. *Regional Development in Africa*, *235*.
Ibimilua, F. O., & Ayiti, O. M. (n.d.). *Environmental Hazards and Sustainable Health in Nigeria*.
IBIMILUA, F. O., & OMIDIJI, A. O. (2024). ASSESSING THE IMPACT OF ENVIRONMENTAL AWARENESS ON SANITATION IN EKITI STATE. *WILBERFORCE JOURNAL OF THE SOCIAL SCIENCES*, *9*(1), 144–166. https://doi.org/10.36108/wjss/4202.90.0170
Jana, T., Sahoo, S., Ramesh, K., Ghosh, S., Raghavan, V., Rayan, R. A., Nalluri, A., Bhardwaj, P., & Sana, S. S.

(2025). Solid Wastes: Basic Knowledge on Sources and Types for Better Management. In *Waste Management and Treatment* (pp. 62–83). CRC Press.
Joseph, K. (2006). Stakeholder participation for sustainable waste management. *Habitat International*, *30*(4), 863–871.
Karabulut, A. İ., Yazici-Karabulut, B., Derin, P., Yesilnacar, M. I., & Cullu, M. A. (2022). Landfill siting for municipal solid waste using remote sensing and geographic information system integrated analytic hierarchy process and simple additive weighting methods from the point of view of a fast-growing metropolitan area in GAP area of Turkey. *Environmental Science and Pollution Research*, *29*(3), 4044–4061.
Klein, N., Ramos, T. B., & Deutz, P. (2020). Circular economy practices and strategies in public sector organizations: An integrative review. *Sustainability*, *12*(10), 4181.
Kumar, A., & Samadder, S. R. (2017). A review on technological options of waste to energy for effective management of municipal solid waste. *Waste Management*, *69*, 407–422.
Lebreton, L., & Andrady, A. (2019). Future scenarios of global plastic waste generation and disposal. *Palgrave Communications*, *5*(1), 1–11.
Malachi, I. G., Rotifa, O. B., Oyediran, J. A., & Oladapo, B. I. (2023). Addressing Poor Living and Health Challenges in Nigeria Local Communities: A Step towards Achieving the UN Sustainable Goals. *European Journal of Science, Innovation and Technology*, *3*(5), 249–260.
Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: a review. *Frontiers in Public Health*, *8*, 14.
Mor, S., & Ravindra, K. (2023). Municipal solid waste landfills in lower- and middle-income countries: Environmental impacts, challenges and sustainable management practices. *Process Safety and Environmental Protection*, *174*, 510–530. https://doi.org/10.1016/j.psep.2023.04.014
Muhammad, S., & Marzuki, A. (2024). Solid Waste Management Application and Its Dilemma in Kano Metropolis-Nigeria. *American Journal of Environmental Protection*, *12*(5), 108–121.
Munir, M. T., Li, B., Naqvi, M., & Nizami, A.-S. (2023). Green loops and clean skies: Optimizing municipal solid waste management using data science for a circular economy. *Environmental Research*, 117786.
Onibokun, A. G. (1999). *Managing the monster: urban waste and governance in Africa*. Idrc.
Özdağoğlu, A., & Özdağoğlu, G. (2007). Comparison of AHP and fuzzy AHP for the multi-criteria decision making processes with linguistic evaluations. *İstanbul Ticaret Üniversitesi Fen Bilimleri Dergisi*, *6*(11), 65–85.
Pernot, E., Hall, J., Baatout, S., Benotmane, M. A., Blanchardon, E., Bouffler, S., El Saghire, H., Gomolka, M., Guertler, A., & Harms-Ringdahl, M. (2012). Ionizing radiation biomarkers for potential use in epidemiological studies. *Mutation Research/Reviews in Mutation Research*, *751*(2), 258–286.
Pujara, Y., Pathak, P., Sharma, A., & Govani, J. (2019). Review on Indian Municipal Solid Waste Management practices for reduction of environmental impacts to achieve sustainable development goals. *Journal of Environmental Management*, *248*, 109238.
Qambrani, N. A., Rahman, M. M., Won, S., Shim, S., & Ra, C. (2017). Biochar properties and eco-friendly applications for climate change mitigation, waste management, and wastewater treatment: A review. *Renewable and Sustainable Energy Reviews*, *79*, 255–273.
Rajpoot, S. (2024). Eco-Friendly Solutions for Sustainable Waste Management: An Approach Towards a Cleaner and Greener Future. In *Waste Management and Life Cycle Assessment for Sustainable Business Practice* (pp. 43–64). IGI Global.
Rane, N. L., Mallick, S. K., Saha, A., Pande, C. B., Rane, J., Roy, R., Alshehri, F., & Radwan, N. (2024). Appraisal on suitable landfill site selection for municipal solid waste disposal using GIS and MIF methods. *Physics and Chemistry of the Earth*, *134*, 103591. https://doi.org/10.1016/j.pce.2024.103591
Salsabila, L., Ariany, R., & Koeswara, H. (2024). Fostering Community-Led Waste Management Through Dynamic Governance: A Case Study of Batam City. *Jurnal Bina Praja*, *16*(1), 187–200.
Serge Kubanza, N., & Simatele, M. D. (2020). Sustainable solid waste management in developing countries: a study of institutional strengthening for solid waste management in Johannesburg, South Africa. *Journal of Environmental Planning and Management*, *63*(2), 175–188.

JRBE JOURNAL OF RESEARCH IN THE BUILT ENVIRONMENT
ISSN 2636-6363
JRBE 2025
VOLUME 2 ISSUE 4
PAGES 170 - 187

Sharma, H. B., Vanapalli, K. R., Samal, B., Cheela, V. R. S., Dubey, B. K., & Bhattacharya, J. (2021). Circular economy approach in solid waste management system to achieve UN-SDGs: Solutions for post-COVID recovery. *Science of the Total Environment*, *800*, 149605.

Shukla, S., Ganguly, R., & Hussain, C. M. (2020). *Hazardous wastes–Types and sources*.

Soltani, A., Hewage, K., Reza, B., & Sadiq, R. (2015). Multiple stakeholders in multi-criteria decision-making in the context of municipal solid waste management: a review. *Waste Management*, *35*, 318–328.

Thamilmaraiselvi, B., Bhuvaneswari, P., Steffi, P. F., & Sangeetha, K. (2024). Solid Waste Management. In *Waste Management and Treatment* (pp. 51–61). CRC Press.

Umar, U. M., & Naibbi, A. I. (2021). Analysis and suitability modeling of solid waste disposal sites in Kano metropolis, Nigeria. *Geocarto International*, *36*(12), 1409–1427.

Vergara, S. E., & Tchobanoglous, G. (2012a). Municipal solid waste and the environment: a global perspective. *Annual Review of Environment and Resources*, *37*(1), 277–309.

Vergara, S. E., & Tchobanoglous, G. (2012b). Municipal solid waste and the environment: A global perspective. In *Annual Review of Environment and Resources* (Vol. 37). https://doi.org/10.1146/annurev-environ-050511-122532

Wang, Y., Fang, M., Lou, Z., He, H., Guo, Y., Pi, X., Wang, Y., Yin, K., & Fei, X. (2024). Methane emissions from landfills differentially underestimated worldwide. *Nature Sustainability*, *7*(4), 496–507.

Yildirim, V., Memisoglu, T., Bediroglu, S., & Colak, H. E. (2018). MUNICIPAL SOLID WASTE LANDFILL SITE SELECTION USING MULTI-CRITERIA DECISION MAKING AND GIS: CASE STUDY OF BURSA PROVINCE. *Journal of Environmental Engineering and Landscape Management*, *26*(2), 107–119. https://doi.org/10.3846/16486897.2017.1364646

Yong, Z. J., Bashir, M. J. K., Ng, C. A., Sethupathi, S., Lim, J. W., & Show, P. L. (2019). Sustainable waste-to-energy development in Malaysia: Appraisal of environmental, financial, and public issues related with energy recovery from municipal solid waste. *Processes*, *7*(10), 676.

Zhang, Z., Chen, Z., Zhang, J., Liu, Y., Chen, L., Yang, M., Osman, A. I., Farghali, M., Liu, E., Hassan, D., Ihara, I., Lu, K., Rooney, D. W., & Yap, P. S. (2024). Municipal solid waste management challenges in developing regions: A comprehensive review and future perspectives for Asia and Africa. In *Science of the Total Environment* (Vol. 930, p. 172794). https://doi.org/10.1016/j.scitotenv.2024.172794

Zhao, T., Gao, Y., Zhan, W., Sun, H., Zhang, T., Li, L., Zuo, W., Tang, X., Li, Y., & Tian, Y. (2024). Municipal solid waste (MSW) under the population shrinking and aging: Spatio-temporal patterns, driving forces, and the impact of smart city development. *Journal of Cleaner Production*, *434*, 140124.