

Waste Management, Littering and Illegal Dumping: A Literature Review

Literature Review: Clean cities and towns: Understanding societal behaviour in order to reduce and divert waste going to

Lizette Grobler, Rinie Schenck and Takunda Chitaka

Waste Research Development and
Innovation Roadmap Research Report

31 MARCH 2022



science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA



UNIVERSITY of the
WESTERN CAPE

DOCUMENT CONTROL

Degree of Confidentiality:	Public
Title:	Clean cities and towns: Understanding societal behaviour in order to reduce and divert waste going to landfills
Author(s):	Schenck C J; Nell C M, Grobler L; Blaauw P F
Date of Issue:	31 March 2022
Grant Holder:	Prof. Rinie Schenck
Organization Report Number:	CSIR/IU/WRIU/2018/019
Prepared by:	DSI/NRF/CSIR Research Chair in Waste and Society Department of Social Work University of the Western Cape P/Bag x17 Bellville Cape Town 7535
Prepared for:	Department of Science and Innovation Directorate Environmental Services and Technologies Private Bag X894, Pretoria, South Africa, 0001
Contract Number:	CSIR/IU/WRIU/2018/019
Keywords:	Illegal dumping; littering; solid waste management
Version:	Final

Any statements, findings and conclusions or recommendations expressed in this research report are those of the authors and do not necessarily reflect the views of the Department of Science and Innovation or the Council for Scientific and Industrial Research

Table of contents

Table of Contents

1.	Chapter 1: Introduction.....	4
1.1	Introduction.....	4
1.2	Brief outline and orientation.....	6
1.3	Scope of the report.....	7
1.4	Research directions in studies of waste.....	9
2.	Chapter 2: Waste management.....	10
2.1	Introduction.....	10
2.2	Stakeholders and responsibility.....	11
2.3	Consequences of poor solid waste management.....	13
2.4	Factors contributing to waste.....	15
2.5	Perceptions of waste and waste management.....	16
2.6	Attitudes towards waste.....	21
2.7	Willingness to pay (WTP).....	27
2.8	Barriers to waste management.....	30
2.8.1	Financial barriers.....	30
2.8.2	Infrastructure.....	31
2.8.3	Technological barriers.....	32
2.8.4	Social and political barriers.....	32
2.8.5	Planning.....	33
2.8.6	Administration.....	34
2.8.7	Capacity.....	35
2.8.8	Engagement and participation.....	35
2.8.9	Structure and systems.....	37
2.8.10	Inappropriate collection methods.....	37
2.8.11	Inappropriate disposal.....	38
2.8.12	Awareness.....	38
2.8.13	Attitude.....	39
2.8.14	Risks.....	39
2.8.15	Legislation and policy.....	39
2.9	Approaches to management of solid waste.....	41
2.9.1	Introduction.....	41
2.9.2	Waste prevention and generation.....	41
2.9.3	Waste handling, separation, storage and processing at source.....	52
2.9.4	Waste collection systems, strategies and practices.....	57
2.9.5	Waste transfer and transport.....	58
2.9.6	Waste separation, processing and transformation of solid waste.....	59
2.9.7	Waste disposal systems, strategies and practices.....	59
2.10	Waste management practices.....	61
2.10.1	Educational institutions.....	61

2.10.2	Awareness and information campaigns	63
2.10.3	Technological approaches	64
2.10.4	Resistance campaigns	65
2.10.5	Educational interventions	66
2.10.6	Green practices and hotel practices	67
2.10.7	Stakeholder participation	69
2.10.8	Stakeholder synergy.....	72
2.10.9	Governance approaches, decision support and selection of alternatives.....	74
2.10.10	Policy and legislative approaches.....	78
2.10.11	Waste picker integration and formalisation	89
3.	Chapter 3: Littering	95
3.1	Introduction	95
3.2	Impacts of litter	97
3.3	Reasons for littering	98
3.4	Attitudes towards littering	103
3.5	Perceptions about littering.....	104
3.6	Anti-littering strategies	105
3.6.1	Introduction	105
3.6.2	Antecedent strategies	107
3.6.3	Consequence strategies	117
3.6.4	Hybrid strategies	117
4.	Chapter 4: Irregular dumping	122
4.1	Introduction	122
4.2	Causes and predictors of irregular dumping	124
4.3	Current irregular dumping challenges	131
4.4	Identifying irregular dumping sites and detection of dumping	133
4.5	Strategies to address irregular dumping	135
4.5.1	Increased availability of waste collection and facilities	135
4.5.2	Surveillance and reporting systems.....	135
4.5.3	Policy	137
4.5.4	Business improvement districts.....	138
4.5.5	Economic incentives.....	138
4.5.6	Criminal law enforcement and enforcement actions	139
4.5.7	Licencing system	141
4.5.8	Urban street greenery	141
4.5.9	Vehicle impoundment policy	142
4.5.10	Education, outreach and community cohesion	142
4.6	4.6 Management of irregular dumping sites	142
5.	List of references.....	145

Literature Review: Waste Management, Littering and Irregular Dumping

1. Chapter 1: Introduction

1.1 Introduction

The literature on solid waste management in Sub-Saharan Africa does not prioritise the political, economic and cultural processes that impact on solid waste generation and management, but rather concentrates on “waste characteristics, performance description and its causes, and household waste generation behaviour” (Njeru 2006: 1048). In terms of municipal solid waste management, De Morais Vieira and Matheus (2018), with reference to Ma and Hipel (2016), note that only 0.69% of studies focus on the social aspects. Moreover, few studies target policies, attitudes and behaviours that contribute significantly to waste failures. Africa and Latin America have produced the fewest studies on the social aspects of this phenomenon (De Morais Vieira and Matheus 2018).

A broader understanding of waste issues is therefore necessary to understand waste management failures and to understand the way waste affects both urban environments as well as residents (Njeru 2006; De Morais Vieira and Matheus 2018). This can prove to be challenging, since urban environmental problems in general originate in complex economic, political and cultural processes (Njeru 2006). In particular, De Morais Vieira and Matheus (2018) also emphasise the interrelated nature of municipal solid waste problems which encompass “more than money and equipment; they include social and cultural relations of local society, such as man-woman relationships, education and beliefs” (De Morais Vieira and Matheus 2018: 79).

Enhancing the understanding of these complex problems is an important step in the striving for city cleanliness. The maintenance of high levels of cleanliness in public spaces improves environmental public health, which is a significant characteristic of liveable, prosperous cities (Hernández et al. 1999; Ong and Sovacool 2012; Kirkman and Voulvoulis 2017; Carmi 2019). In addition, the Sustainable Development Goals (SDGs)

agenda foregrounds the protection of the environment and the preservation of health by promoting proper solid waste management in cities in terms of reducing waste generation, and increasing reuse and recycling (Ziraba et al. 2016). Proper solid waste management promotes SDG 3 (healthy lives and promotion of wellbeing), SDG 6 (water and sanitation), SDG 13 (dealing with climate change and its impact) and SDG 11 (by increasing the percentage of solid waste regularly collected and well managed) (Ziraba et al. 2016).

Moreover, as Olukoju (2018) notes with reference to the work of Marshall and Farahbakhsh (2013) and Okot-Okumu (2012), the efficiency and effectiveness of solid waste management serve as a barometer of good governance, as well as a measure to gauge the success of municipal management and urban reforms. The drivers of the research on clean cities do not only entail a survey of perceptions of and attitudes towards waste and waste management, but the identification of best practices to address the complex problems associated with city cleanliness. These best practices also represent good governance and must in turn inspire best practices in the context of South African waste management.

This literature review was generated as a response to one of the deliverables indicated in the CSIR funded Clean Cities/Towns Project. The deliverable was unpacked during a workshop of relevant stakeholders in January 2019. The initial results were presented in August 2019. The literature review was updated in the aftermath of the pandemic to also include sources on waste generated during the pandemic and the challenges resulting from containment strategies and personal protective equipment, including face masks and gloves. According to Sarkodie and Owusu (2021), the restriction of commercial activities as well as mobility and manufacturing limitations had a profound influence on waste management. The increase in waste and particularly single-use products and the aftermath of panic buying presented new challenges and placed the spotlight particularly on plastic pollution (Sarkodie and Owusu 2021). The management of waste that poses health risks also necessitated adjustments to waste management processes. The initial literature review mainly considered peer-reviewed articles drawn from the databases of two universities in the Western Cape during February to July 2019. The selection criteria for the articles included the search terms “solid waste management”, “littering” and “illegal dumping”, and “waste disposal” combined with the search terms “perceptions” and

“attitudes”. The expansive brief for the research report widened the scope of the first chapter and complicated detailed searches. A decision in consultation with the project leader resulted in the elimination of the category of “assessment criteria for solid waste management systems”. Other exclusions were waste characterisation studies, evaluations and comparisons of technical and chemical treatment of waste options or assessment criteria for solid waste systems. During the update these search results were augmented by a search on Google Scholar restricted to the period of 2019 - 2021. The search terms “littering” and “illegal dumping” as well as “indiscriminate dumping” were applied. The term “illegal dumping” is currently a contentious concept in waste research. However, research has demonstrated that the term is recognised internationally, although it is in certain instances discouraged in research proposals. In terms of the broadest conceptual category an initial search for “solid waste management” resulted in an extensive and very broad corpus of sources. Consequently, the search term was narrowed to “household solid waste management”.

This literature review can be read as an exploratory narrative literature review. It aims to introduce the main themes emerging from articles on perceptions about waste management and questions related to littering and illegal dumping available from the academic library databases from two South African universities and supplemented by a Google Scholar search to include themes arising during the last two years of the COVID-19 pandemic.

1.2 Brief outline and orientation

The introduction to the literature review is followed by a short delineation of scope of the report and an orientation situating and juxtaposing the literature on waste management of the Global South and North. Chapter Two deals with the classic aspects of waste management, including the stakeholders, consequences of poor solid waste management, the factors contributing to waste and perceptions on waste and waste management. A section on attitudes to waste, which is important in terms of promoting behavioural change, is followed by a lengthy section on the extensive barriers to municipal solid waste management.

The section on approaches to solid waste management surveys the literature on the

different components of solid waste management and expands considerably on the topics of waste generation and prevention. Finally, the last section addresses responses to waste management to promote best practices.

Chapters Three and Four cover the undesirable waste disposal activities of littering and illegal dumping. Chapter Three also describes the impacts of litter, traces the reasons for littering and includes brief sections on attitudes towards and perceptions of littering. The section on strategies to counter littering proceeds from antecedents to littering to its consequence and hybrid strategies to deal with it.

The fourth chapter reviews causes and challenges as well as predictors of irregular dumping, followed by a section on strategies to address illegal dumping. Since the literature in South Africa on littering and irregular dumping seems to be less abundant, it is hoped that Chapters Three and Four in particular can serve as a starting point for further research. To conclude, it is necessary to point out that the sections on waste management practices, anti-littering strategies and management of irregular dumping complement each other. Moreover, it is conceded that thematically the chapters actually form a unit and should be read together.

1.3 Scope of the report

The report has three main research focal points. Firstly, it provides a review of the literature on perceptions and attitudes regarding waste, waste management, litter and illegal dumping. Secondly, it investigates existing waste management strategies and practices with the aim of identifying best practices. Thirdly, it surveys research on two major challenges to waste management, namely littering and illegal dumping. The report will not focus on waste characterisation studies, characterization of hazard profiles of waste (such as Barbale et al. (2021) on the hazard profiling of compostable shopping bags and Da Paz et al. (2020) on the environmental impact risks of construction and demolition waste in Brazil), evaluations and comparisons of technical and chemical treatment of waste options, assessment criteria for solid waste systems or life-cycle assessments (such as Civancik-Uslu et al. (2019) on the LCA of carrier bags and the development of a littering indicator). It should be noted, however, that studies on waste composition and characterisation have been conducted relatively widely during the last

three years. See, for example, Abebaw (2019) (on characteristics of solid waste in Kilinto, Ethiopia); Elhamdouni et al. (2019) (on waste characterisation in Khenifra region, Morocco) Addrell and Gunawardena (2020) (in Colombo 15, Sri Lanka); Phuong et al. (2021) (on characterisation and analysis of household solid waste composition in Hanoi City, Vietnam) and Nkum et al. (2021) (on composition of household waste in La-Nkwantanang-Madina Municipality, Greater Accra Region, Ghana).

Definitions of the broadest term used in this literature review, namely “waste”, have the tendency to be subjective, since objects that might be viewed as waste to some might be perceived as valuable resources by others (Aguadze 2020). Two early definitions by Gilpin (1996) and Palmer (1998) both emphasise the characteristic of being unwanted. Gilpin (1996) adds economic uselessness and also mentions that the act of disposal can be accidental or may happen in another way. Palmer (1998) restricts the notion of waste to materials generated by human activities. Aguadze (2020: 1), drawing on Leton and Omotosho (2004), defines solid waste as “the non-liquid or nongaseous products of human and animal activities that are unwanted”. Municipal solid waste includes everyday items emanating from residential, commercial and institutional contexts as well as from hospitals, which have lost their value to their owners and which are then discarded (Abegaz et al. 2021). The United States Environmental Protection Agency (2018) excludes industrial, hazardous and construction and demolition waste from its definition of municipal solid waste. Urban household solid waste emanates from human, animal, domestic and economic activities in urban households and may be organic and biodegradable as well as inorganic and non-degradable (Aguadze 2020, drawing on Senkwe and Nwale 2001, but see Ogwuche & Yusufu 2011).

Solid or municipal solid waste management can be defined as “the planning, financing and implementation of programs for solid waste collection, transportation, treatment and final disposal in an environmentally and socially acceptable manner” (Ziraba et al. 2016: 57). According to Aguadze (2020), the elements of waste generation and recovery must also be included. Conversely, poor solid waste management indicates a failure to uphold set standards at any of the previously mentioned stages of waste management (Ziraba et al. 2016).

1.4 Research directions in studies of waste

Social studies of waste have covered themes as diverse as the nature of waste and the management of waste (Millington and Lawhon 2018). Geographical and allied research in the Global South differs empirically from waste research in the Global North. These differences are related to the nature of waste, intellectual traditions, research networks and publication pressures. As Millington and Lawhon (2018: 3) state:

From the perspective of the Global South, waste studies can be read as having constructed a problematic though largely implicit set of contrasts: the North is formal, (increasingly) sustainable, and a successful model to emulate; the South is informal, crisis-ridden and failing.

In terms of substantive differences, informality and governance failures are emphasised by both northern and southern scholars in relation to the Global South. In terms of the former, informal waste has been investigated as a marginal livelihood strategy, informal work has been interrogated in terms of its environmental and economic contribution, and scrutinised in relation to its coordination and formalisation. Nevertheless, as Millington and Lawhon (2018) contend, cross binary thinking can benefit thinking about waste and can address “the limitations of the over-separation of the North from the South in waste studies” (Millington and Lawhon 2018: 3). In terms of governance of wastescapes, Millington and Lawhon (2018:2) recommend that more research should be done on “everyday waste practices as well as analyses of ownership, entitlement and appropriation”. Research on adding value to waste can be augmented by attending to “globally shifting dynamics and their relationship to the materiality of waste” in order to re-examine existing political strategies. Attention can also be paid to technologies involved in the transport and processing of waste.

2. Chapter 2: Waste management

2.1 Introduction

The issue of municipal solid waste has become a significant global concern exacerbated by continual world population growth, increased consumption, more complex waste composition and, consequently, a greater need for environmentally and socially acceptable waste disposal involving different waste streams, e.g. food, packaging and paper waste, among others (Filho et al. 2016; Kwenda et al. 2022). In fact, it is projected that the estimated quantity of municipal solid waste generated in the world will increase to 2.2 billion tonnes per year by 2025 (Filho et al. 2016, referring to Hoornweg and Bhada-Tata 2012). Moreover, the generation of solid waste and cost of solid waste management in lower-income countries is estimated to at least double over the next two decades (World Bank 2020; Kwenda et al. 2022).

Although municipal solid waste presents a problem for industrialised nations, it is of particular concern in developing nations (Filho et al. 2016; Ngbolua et al. 2019), which represent 70% of the world's population (Filho et al. 2016). Seth et al. (2014) state that nine out of ten African cities struggle with dire waste disposal issues. Some of the challenges facing municipal solid waste management systems in developing countries include service provision, inadequate waste recovery, operational challenges and waste disposal (Kwenda et al. 2022). Not only are developing countries struggling with growing waste volumes, but the costs involved, waste management technology choices, and local and global waste aggravate the present challenges. As Filho et al. (2016) note, waste streams, collection, treatment and disposal methods are combined in waste management systems, mostly based, in terms of preference, on the widely accepted underlying premise of the waste hierarchy. These systems and solid waste management practices differ to a large extent within countries and across regions and countries (Filho et al. 2016; Ziraba et al. 2016). In developing countries the re-use of waste and waste sorting are still not the norm. Consequently, solid waste disposal on open dump sites and waste burning still take place frequently. According to Ziraba et al. (2016), differences in waste management practices reveal the state of waste management laws and policies and their enforcement, the availability of funding, as well as of waste composition and generated quantities. Ziraba et al. (2016: 58) describe solid waste management in many developing

countries as “not mainstreamed, poorly funded and [...] always [falling] below expectation”. Private providers and municipal authorities share the responsibility for solid waste management in many developing countries. Collection takes place from source or temporary dumping grounds, and waste is disposed of at open dumping sites situated on the city outskirts. The latter are spread out and exposed and trucks deposit the waste. Scavenging for usable articles and recyclables often takes place and waste bulk is reduced by burning. Complex waste composition containing industrial, medical, electronic and human waste will not get sorted (Ziraba et al. 2016).

2.2 Stakeholders and responsibility

In Nigeria, Olukoju (2018) investigated the roles of various stakeholders in waste management. A specialised agency was established in Lagos referred to as Lagos State Waste Management Authority (LAWMA). Stakeholders include individuals, households, local communities, NGOs and the state. Of these stakeholders, the government of Lagos State is singled out as the most important role player in terms of its regulatory function and direct participation in waste management. Non-state stakeholders also play a key role. Apart from formal private sector operators, informal private sector operators also contribute to solid waste management. These informal role players include cart pushers, waste pickers/scavengers, resource merchants and recyclers. The cart pushers collect door-to-door, the waste pickers recover material and sell it to the resource merchants, while the recyclers produce usable products or raw materials for further industry use from the recovered materials. These stakeholders play an important role in supplementing the gaps in state-run waste collection and disposal services. The waste pickers are the most critical workers in the chain.

Olukoju emphasised that women are important stakeholders “in the community ownership of waste” (2018: 101) and that they are significant waste generators and influencers in terms of encouraging sorting at source and discouraging illegal dumping. More recently, Agudze (2020) investigated the role of three groups of stakeholders, namely waste generators (households, private establishments and institutions), service providers (the New Juaben Municipal Assembly, Zoomlion Ghana Ltd) and service regulators (the Municipal Assembly and Assembly members) in waste management in terms of the provision of facilities, collection, disposal and capacity. Ajani and Fakunle (2021), in a

study in low-income residential areas in Nigeria, affirmed the importance of community participation and in particular the participation of local grassroots associations in enabling the successful institutional frameworks for waste management.

In Eastern European countries such as Poland, Hungary and the Czech Republic the increase in recycling of urban solid waste indicates reform in urban solid waste management related to developments in the recycling industry and the local population's increased involvement in separate waste collection (Gorobets 2019). Gorobets (2019) ascribes the stagnant waste recycling in Russia, China, Mexico and other developing countries to ecological irresponsibility, particularly among governments, and the deficient recycling infrastructure. He recommends educational reforms (awareness raising about effects of waste accumulation and personal liability) as well as administrative reforms (high penalties for illegal dumping and mixed waste collection as well as incentives for waste separation) to cultivate ecological responsibility in the striving for waste minimization and to foster a culture of recycling (Gorobets 2019).

A study conducted in Accra, Ghana found most of the respondents viewed children as responsible for waste management, followed by community members, district assembly and private operators (Yoada et al. 2014). In a recent study in Windsor, Johannesburg 25% of the research participants revealed that they believe that municipal authorities are responsible for effective solid waste management by crafting and developing adequate policies and educating the public to be involved in solid waste management (Kubanza and Simatele 2020). A similar percentage believed households should take responsibility for solid waste management, since they generate the waste (Kubanza and Simatele 2020). Similarly, in a study conducted in the Kingdom of Bahrain, the majority of respondents also viewed the cleanliness of public areas as a responsibility shared between the government and the public (Freije et al. 2019).

A study in Abadan, Iran (Babaei et al. 2015) found that women took greater responsibility in terms of the domestic household and there was reasonably effective participation in source separation and recycling. Consequently, one of the recommendations was that training programmes should focus on this group (Babaei et al. 2015).

In a study focusing on Wolkinte, Ethiopia, Wassihun and Gichamo (2019) note that the failure to take the initiative and accept responsibility for waste management as an expression of environmental citizenship is tied up with divisive identity politics.

Al-Khatib et al. (2009) note that street cleanliness is a shared responsibility of citizens and local authorities. Willingness to volunteer in street cleaning campaigns can be linked to a strong sense of belonging that community members feel in relation to their local public places (Al-Khatib et al. 2009).

2.3 Consequences of poor solid waste management

Waste disposal practices can contribute to environmental and health problems as a result of the emission of harmful gasses and leachates (Akmal and Jamil 2021). Moreover, if harmful objects, such as sharp syringes, razors and blades are not disposed of properly, they pose dire health risks (Akmal and Jamil 2021). Particularly in the era of the COVID-19 pandemic, healthcare waste combined with related infectious waste including tissues, gloves, masks and gauze create new risks and challenges (Khan 2020). Khan (2020) mentions the increase in mixed waste, more plastic and the challenge with selling reusable items that might transmit the virus, the absence of estimates of the quantity of household hazardous waste generated, increased littering and illegal dumping as well as open burning, inadequate awareness of proper waste management and consequently the need for new legal norms to address the pandemic. In Africa waste management involves huge public health and environmental challenges (Hoornweg and Bhada-Tata 2012; Omer 2021).

Ziraba et al. (2016: 60) indicate that the solid waste impacts on health “may range from mild psychological effects to severe morbidity, disability or death”. They identify four health impact categories: (1) infection transmission of bacterial, viral and other organisms causing disease; (2) physical bodily injury that may result from cuts, drowning, blunt trauma, chemical or radiation injuries, leading to skin or inhalation burns to longer-range effects; (3) long-term exposure can cause non-communicable diseases such as cellular damage, cancer or bodily organ injury and damage; and (4) emotional/psychological effects (Ziraba et al. 2016). These authors recommend prioritising waste management as a social service with adequate budget allocation, engaging several stakeholders to

manage waste and foster a sense of responsibility, mandating the use of protective gear, educating the public on the role of the individual in proper waste management, implementing a comprehensive plan building on best practices in other countries. and encouraging a culture of recycling.

The environmental impact of waste disposal practices and particularly inappropriate waste management practices such as burning, stockpiling and disposal into water bodies is pronounced (Wen et al. 2019; Wulandhary et al. 2019). Some of these practices such as open dumping and indiscriminate waste burning are particularly prevalent in developing countries (Abebaw 2019). An estimated 30-50% of generated waste in developing countries is managed adequately (Teym 2021). The remainder is burned or discarded in open spaces or unregulated landfills with a detrimental effect on environmental quality (Teym 2021). Negative consequences include contamination of surface and groundwater as well as soil and air pollution, disease transmission, methane release (Abebaw 2019), detrimental aesthetic impact, landscape damage, fire risk, noxious odours, financial costs of cleaning up waterways, reservoirs silting up, decreased plant productivity, deteriorating structures and foundations, and diminished land value (Paghasian 2017; Sultana et al. 2021).

Visual pollution can also result from poor solid waste management. Interestingly, a study in Kuching, Sarawak, Malaysia conducted by Chung et al. (2012) investigated visual pollution caused by insufficient waste management of waste containers. The aesthetic appeal of waste management solutions such as storage facilities does not seem to be a significant factor - damaged bins, exposed waste containers, non-standardized waste containers and inappropriate waste container location were not perceived as causes of visual pollution by the majority of respondents. However, waste containers with overflowing waste were perceived as visual pollution.

In terms of the consequences of specific categories of solid waste, food waste impacts on the environment through producing greenhouse gas emissions and reduced availability of water and land resources (Scialabba et al. 2014; Yu and Li 2020), a damaged economy and impaired natural resources and nutritional security. The latter is of particular concern since an estimate of more than 925 million people are chronically

undernourished and food waste is therefore a significant ethical issue (Chalak et al. 2018) A recent study by Redlingshöfer et al. (2020) estimates that 815 million humans lack safe and nutritious food (Yu and Li 2020).

2.4 Factors contributing to waste

Generally, the increase in municipal solid waste is attributed to rapid urbanisation, population growth, unfettered modernisation (Zhen-shan et al. 2009; Alam and Ahmade 2013; Abegaz et al. 2021), unrestrained economic development, mismanaged tourist flow (Malinauskaite et al 2017; Zambrano-Monserrate et al. 2021), higher living standards, consumerism and improved lifestyles (Astane and Hajilo 2017; Liu et al. 2019; Alwedyan 2021). Zambrano-Monserrate et al. (2021) studied the influence of GDP, population, urbanisation and the flow of tourists in 173 countries. The authors found that GDP increases municipal solid waste production in high- and upper-middle-income countries and suggest that this finding may be related to high consumption levels, since consumption is a function of income (Zambrano-Monserrate et al. 2021). They also found that population numbers have a higher impact on waste generation in high-income rather than in low-income countries. In particular, the percentage of urban inhabitants affects waste generation in high- and upper-middle-income countries. In addition, the flow of tourists has an impact on waste generation in all countries, although it is higher in high-income countries (Zambrano-Monserrate et al. 2021). In a study in Homs City, Syria (Noufal et al. 2020), and one in Irbid City, Jordan (Alwedyan 2021), socio-economic factors that were found to significantly predict solid waste generation were family size, monthly income, education level, gender of the household head and the age of the household head. A study conducted in Gulberg Town, Lahore, Pakistan, found a correlation between higher income and higher waste generation (Jadoon et al. 2014). In addition, the authors investigated seasonal influence on waste generation and found an increase during monsoon months and a decrease in spring and winter (Jadoon et al. 2014).

Food waste, as a type of waste of global concern (Sharma et al. 2021), has received increased attention in research literature (Aschemann-Witzel et al. 2015). Global annual food waste is estimated at 1.3 billion tonnes (Paritosh et al. 2017; Sharma et al. 2020; Sharma et al. 2021 [expressed as tons]). A study in Accra, Ghana, for example,

emphasises the significance of food waste in relation to other types of waste and found that the majority of domestic solid waste consisted of food debris and plastics (Yoda et al. 2014). As a result of the increased attention to this research theme, the causes of food waste also receive ample coverage. Chalak et al. (2018), for example, distinguish between causes of food loss or waste¹ in developing and developed countries. In developed countries, food waste is attributed to consumers and connected to their values, behaviours and attitudes. In developing countries, almost two thirds of food waste occurs at the pre- and post-harvest and processing stages. Agricultural practices, limitations of technology, finances and labour, infrastructural challenges where storage, processing and transport are concerned and transport are all factors contributing to food waste in this context (Chalak et al. 2018). Food loss and waste are associated with mishandling and uncoordinated activities including harvesting, transportation, manufacture, storage and distribution. Additionally, consumers' attitudes and behaviours regarding waste generation also play a role. Factors connected to the food supply chain, including package sizes and sales promotions, influence consumer behaviour (Chalak et al. 2018).

2.5 Perceptions of waste and waste management

Fakunle and Ajani (2021) state that perception is one of the key determinants of behaviour. In fact, perceptions of good and bad behaviour can in certain instances be more significant in waste-generating behaviour compared to social and cultural norms (Razali et al. 2020; Knutsson et al. 2021). Consequently, the perception of solid waste management could significantly relate to waste management behaviour. However, as Knutsson et al. (2021: 2) caution, studies on waste behaviour motivation do not often “capture in-depth, descriptive case-based accounts of citizens' perceptions of waste management systems, and how such knowledge might be leveraged to facilitate communication and future change in waste management behaviour”. It has been suggested that a negative perception of waste management and deeming it personally challenging could lead to a lower probability of commitment to waste management behaviours (Nguyen et al. 2015; Knutsson et al. 2021). Conversely, studies ought to focus

¹ According to the Food and Agriculture Organization (FAO) unintended food losses occur in the earlier stages of the supply chain, while food waste occurs on the consumer's side and is associated with deliberate decisions. The FAO defines food waste as “good quality food along the value chain suitable for human consumption but ultimately discarded” but not including unavoidable or inedible material (Chalak et al. 2018).

not only on superficial coverage of waste-related perceptions, but could better serve waste management agendas by investigating the determinants of positive perceptions of waste management.

The literature on perceptions of waste and waste management cover a wide range of themes and geographical areas. Perception studies of waste management were, for example, conducted in urban Accra, Ghana (Yoda et al. 2014), Nigeria and Guyana (Oyedotun et al. 2020), Nepal (Acharya et al. 2021) and Khulna City Corporation Area, Bangladesh (Amin et al. 2005). The residents' perceptions of domestic waste disposal was investigated in Ijebu Ode, Southwest Nigeria (Banjo et al. 2009).

Some studies sought to establish satisfaction levels in relation to waste removal services. For example, low rates of satisfaction were recorded in Accra, Ghana (Yoda et al. 2014). Similarly, in other developing countries – such as in certain areas of South Africa and Nigeria – satisfaction with municipal collection services is low (Ezebilo and Animasaun 2011; Dlamini et al. 2017). Although mega-events can even out perceptions about solid waste management services, differences in perception about service provision re-emerge after such events, for example, after the 2007 Commonwealth Heads of Government meeting (CHOGM) in Kampala, Uganda. Dissatisfaction with waste services can be addressed by consulting with local residents regarding the provision of waste management services (Barboza et al. 2011).

Public perception of risk is an important aspect to consider in environmental policy, particularly in the USA (Wagner 2004). In turn, public perceptions of risk are influenced by the mass media through identification, framing, visualisation and dramatization of environmental problems. In addition, public risk perception, media attention, problem construct and discovery conditions determine whether a problem can be addressed through policy interventions and, if so, what the design would look like. In the USA the conditions that were responsible for the increased significance of hazardous waste impacted on the risk perception in the media and the public, and led in turn to increased media attention, as well as scrutiny from government, environmental groups and industry. Hazardous waste was eventually perceived as a national environmental problem by the public and media (Wagner 2004).

General concerns about solid waste management facilities include issues of pollution and health, nuisance and damage to nature, as is evident from a study in Nigeria (Ohakwe et al. 2011). As noted by Peeples (2003), community opposition to facility siting increased with greater awareness of environmental risks. Therefore, planning should take into account communities' perceptions of risks when conceptualising controversial facilities. Respondents displayed concerns about aesthetics, dust, smoke, foul odours, insects, rodents and stray dogs and other animals, as well as air pollution. Noise was a minimal concern and waste picking activities were not viewed as a serious health hazard (Al-Khatib et al. 2015). Related dumpsite problems include noxious emissions and other nuisances (Al-Khatib et al. 2015). In a Nigerian study respondents were concerned about pollution and health effects, nuisance and damage to nature. As in the Palestinian study, air pollution was an issue (Ohakwe et al. 2011).

Respondents living near solid waste facilities in Florida, USA, were not more concerned about dangers associated with landfills than people living farther away. Their perceptions were related to the information they had about landfills. Where concerns were aired, they involved personal health and environmental safety and not property values and traffic issues (Johnson and Scicchitano, 2012).

Discrepancies between results on health and environmental risks obtained from scientific epidemiological studies and perceptions were noted in a study on perceived impacts of e-waste recycling sites in Ghana. In terms of perceptions, the economic opportunities offered by e-waste had an impact. Such a divide may call for policy interventions on multi-sectoral level to increase public acceptability and participation in waste management (Agyei-Mensah and Oteng-Ababio 2012).

Healthcare staff in hospitals have a higher perception of risk than waste workers and patients, while visitors had a lower perception of risk as was evident from a study conducted in hospitals in the Algarve region in Portugal. Healthcare staff relate risk perceptions to the difficulties of correct waste-separation practices and the lack of knowledge about the importance of separation (Ferreira and Teixeira 2010).

In a study by Sessa et al.(2010) in Italy, it was found that younger females without university education believed that improper waste management and waste burning is associated with cancer and the contraction of allergies. Educational programmes were suggested to inform residents regarding waste hazards.

Within the context of a hospital in Portugal, defective waste separation was found to contribute to daily contact with waste (Ferreira and Teixeira 2010). Risk perceptions are positively associated with the degree of contact, the difficulties of correct waste separation and a lack of knowledge about the importance of waste separation. Respondents in a study in Accra, Ghana also associated the contraction of malaria and diarrhoea with improper waste management (Yoda et al. 2014).

Perception studies were also conducted about specific waste management facilities and sites, for example, site selection pertaining to a sanitary landfill in the West Bank, Palestinian territory (Al-Khatib et al. 2015) and the perceived visual aesthetic quality of waste storage facilities on site in Kuching, Sarawak, Malaysia (Chung et al. 2012). Al-Khatib et al. (2015) highlighted fairness in selecting landfill sites as an important social factor (West Bank, Palestinian Territory). Public participation must be considered in the landfill site selection and the development of solid waste management regulations. Therefore effective public involvement opportunities should be available (Al-Khatib et al. 2015).

Perceptions about the effects of unwanted facilities may prevent construction and change the siting of the facilities. The rhetoric of environmental justice movements may play a significant role in facility location. Stakeholders frame environmental controversies in a way that is beneficial to them, as was illustrated in the dispute about the construction of a garbage incinerator in South-Central Los Angeles (Peeples 2003). In this dispute about the location of an incinerator pro-incinerator stakeholders represented communities located at potential sites as being more receptive to the construction of an incinerator compared to more affluent, powerful and resistant communities in other locations. However, the affected community contested the portrayal of their community through their own rhetorical strategies. In this way they demonstrated political agency and fostered new alliances with other communities where further incinerators might be located. The

use of these rhetorical strategies might lead to a shift in political support for the siting of controversial waste management facilities. Apart from rhetorical strategies aimed at altering perceptions of siting of waste management facilities, other factors can also contribute to negative perceptions of waste disposal facilities and the NIMBY syndrome. In a study conducted in Taiwan (Shen and Yu 1997) factors that were identified included environmental consciousness increased by media, economic growth and urbanisation and the emergence of “self-help actions”, for example, extra-legal actions such as demonstrations, protests and blockades from the public within the context of political liberalisation

In addition, the management of specific waste streams, for example, E-waste in Kuala Lumpur, Malaysia (Akhtar et al. 2013) and in Limpopo province, South Africa (Uhunamure et al. 2021) were studied. Researchers also investigated perceptions of risks and dangers associated with municipal solid waste management (Al-Khatib et al. 2015).

Other perception studies focused on specific elements of solid waste management such as recycling. Perceptions of recycling and recycling benefits to households were investigated in e.g. Kaduna metropolis, North West Nigeria (Abd’razack et al. 2017). Bom et al. (2017) investigated public perceptions and practices of solid waste recycling in the City of Larami, Wyoming. They concluded that citizen involvement is essential to increase recycling. Furthermore, maintaining an inspired, motivated, educated and informed population is pivotal to long-term recycling success. Public engagement should range from involvement in planning, pre-implementation, policy formulation and decision making to highlight reasons for a recycling programme and the accompanying benefits. Civic involvement not only induces participation and ownership, but creates opportunities for stakeholders to deal with problems, foster consensus, identify solutions and encourage commitment. The authors recommended an aggressive education policy, incentive policies and a master plan to encourage stronger public participation.

In a case study conducted in Oulu, Finland, Ylä-Mella et al. (2015) examined consumers’ awareness and perceptions regarding mobile phone recycling and reuse. Although consumers’ awareness of the importance and existence of the waste recovery system was high, phones were not recycled frequently. The study found that the waste

management system did not facilitate the return of small waste electrical and electronic equipment (WEEE) items. The respondents were not committed to returning end-of-use electronics to collection centres. The study recommended that more information needs to be disseminated and awareness raised about mobile phones in Finland. In particular, consumers need to be informed about retailers' take-back policies.

Perception studies did not only encompass residents' perceptions of waste-related themes but also investigated the factors that could influence perceptions. Perceptions about waste management are, for example, influenced by environmental knowledge and attitudes (Singhirunnusorn et al. 2012). Other factors included socio-demographic characteristics such as sex, age, marital status, religion and level of education (Yoda et al. 2014), profession, locality type, monthly family income and district (Al-Khatib et al. 2015). Social capital (social trust, institutional trust, compliance with social norms and social networks) may also have a significant effect on the perceptions regarding market-based instruments to minimise waste volume and increase recycling (Jones et al. 2010).

2.6 Attitudes towards waste

Theoretically attitudes are relevant to the theory of planned behaviour. Higher intention or motivation is associated with positive attitudes, subjective norms and perceived behavioural control (Apinpath 2014). Apinpath (2014) states that a high correlation of attitudes, subjective norms and perceived behavioural control to behavioural intention and subsequently to behaviour have been confirmed. In a study conducted in Thailand (Apinpath 2014) the theory of planned behaviour was applied to understand intention with regard to separate disposal of recyclables into a specific bin. Attitudes, subjective norms and perceived behavioural control were associated with intention to dispose of recyclables in separate bins.

Interest in environmental issues is a significant factor in the development of sound environmental attitudes (Johnson and Scicchitano 2012). In turn, environmental attitudes may explain environmental behaviour (Kulatunga et al. 2006; Song et al. 2016a & b). Research into residents' attitudes also makes an important contribution where choices need to be made about appropriate solid waste management systems for a particular context; such research should complement research on technical aspects and

implementation costs (Al-Khatib et al. 2014; Song et al. 2016a & b). Gauging residents' attitudes assists in creating consensus and support for waste management choices. Furthermore, formulation and implementation of policies and recycling facilities must be based on consumer behaviour and willingness to pay to recycle solid waste (Song et al. 2016a & b). Respondents in a study in Macau were positive about source separation and related the practice to sustainable management of solid waste and to effective solid waste treatment. They were also willing to sort solid waste at home, if required. However, respondents exhibited low environmental awareness as became evident from poor source separation (Song et al. 2016a & b). The findings of a study in Zhengzhou, China (Dai et al. 2017) also indicate that a positive attitude to waste separation can lead to an increase in the willingness of undergraduates to engage in waste separation. However, willingness did not equate to appropriate behaviour and was not accompanied by increased waste separation.

Environmental consciousness/awareness affected recycling and waste minimisation attitudes positively (Aini et al. 2002). However, earlier studies cautioned against inferring recycling behaviour based on general environmental attitudes, rather recommending inferences based on attitudes towards recycling (Aini et al. 2002). Within the context of a study conducted in Dhaka City Bangladesh, waste generation was also affected by willingness to separate (Afroz et al. 2011). In fact, environmental consciousness increased the likelihood of willingness to separate (Afroz et al. 2011). Consequently, to raise environmental consciousness and increase the willingness to minimise waste, awareness raising, promotion of knowledge and motivating a concern for the environment should be foregrounded in policy. Residents were found to display positive attitudes toward solid waste minimisation, willingness to minimise household waste and recycling regularly. Households agreed to implement and participate in the waste management programme. However, there was low participation in waste minimisation (Afroz et al. 2011), which echoed findings in earlier studies relating to positive attitudes not translating into recycling behaviours (Aini et al. 2002). A study by Babaei et al (2015) also concluded that attitudes towards solid waste separation and recycling did not necessarily indicate adequate knowledge and appropriate practices. Dai et al. (2017) concluded from a literature review that the relationship between willingness and behaviour in waste separation behaviour is contentious. In addition they found that a positive attitude to waste

separation, although it increased the willingness of undergraduate students to separate waste, was not accompanied by increased waste separation behaviour. Conversely, a study conducted in Kumasi, Ghana by Owusu et al. (2013) found that households with positive attitudes toward environmental and health effects, suggest higher participation in source separation.

A strong positive attitude to recycling correlated better with recycling behaviour (Aini et al. 2002). Willingness to minimise waste was also higher in middle-aged people compared to young and old people (Afroz et al. 2011).

Concern about the operational impact of solid waste management facilities is another important aspect of attitudes towards waste and waste management. Residents' concern centred on pollution and health effects, damage to nature and cost in a study conducted regarding attitudes towards solid waste management facilities in three municipalities in Japan (Rahardyan et al. 2004).

A study in three cities in south-eastern Nigeria (Ohakwe et al. 2011) indicated that people were mostly concerned about the pollution and health effects of solid waste facilities. This study confirmed earlier research by Rehardyan et al. (2004). Concerns about pollution and health effects were followed by concerns about nuisance and damage to nature. Air pollution was a major concern (Ohakwe et al. 2011). In a study conducted in the Hebron district, Palestine, concern about water pollution (61.1%) as opposed to air (48.1%) and soil pollution (36.3%), was significant. Gender correlated significantly only with concerns about air pollution, while age did not show a significant correlation with any of the concerns. Concern about damage to fauna and flora (47.8%) and truck accidents (36.7%) caused by solid waste management facilities were also expressed. Age was a factor impacting the level of concern indicated by respondents about damage to fauna and flora. In particular, middle-aged respondents were less concerned than younger and older age groups, but gender did not have an impact on their level of concern. Concern about truck accidents were affected by both gender and age. Women were more concerned about truck accidents than males and the youngest age group also expressed more concern than other age groups_ (Al-Khatib et al. 2014).

A study in Laogang, China by Che et al. (2013) affirmed that Not-In-My-Backyard syndrome may often delay or prevent the installation of sewage treatment works, or waste disposal and incineration facilities. In China this attitude has also been recognised and studied since the late 1980s (Che et al. 2013). In general, close proximity to waste management facilities heightens the concerns of residents about health, environmental quality, risk of technological accidents, destruction due to natural disasters and property devaluation (Che et al. 2013). In the study area most residents reported odour annoyance as a dominant problem, but did not consider associated noise, visual impact and loss of property value as major concerns. There was a definite correlation between odour annoyance and distance from the facility, with 100% of residents living within 3 km from the landfill reporting odour annoyance (Che et al. 2013). Local communities opposed a waste treatment facility in their vicinity, but if this was inevitable, they expressed a preference for incineration (78.39%).

Despite the concerns about pollution, damage to fauna and flora that emerged in a study in the Hebron district, Palestine, people were positive about the benefits of solid waste management facilities, particularly about the heat supply that could be generated by incinerators (Al-Khatib et al. 2014). The NIMBY attitude has been defined as “intense, sometimes emotional, and often adamant local opposition to local proposals that residents believe will result in adverse impacts” (Johnson and Scicchitano 2012). In the study conducted in the Hebron district, Palestine, more than two thirds of the respondents were opposed to the building of an incinerator 1 km from their houses. There were no significant correlations evident with this opposition and the age or sex of respondents. More than half of the respondents displayed resistance to the building of a sanitary landfill 1 km from their houses, with young people showing the highest opposition. Age showed a significant correlation with this concern. Finally, more than two thirds of the respondents opposed the building of a waste recycling facility 1 km from their houses. Generally, there was a negative attitude towards the building of any solid waste facility 1 km from the respondents’ homes. Young people again displayed the most intense opposition. The literature on environmental attitudes creates the impression that NIMBY-type attitudes are prevalent when decisions about the location of public facilities are made (Johnson and Scicchitano 2012). The increase in NIMBY attitudes is related to a broader environmental ethic, fear of unknown risk, an increase in accessible public information

and declining confidence in the ability of government and industry to make informed, prudent and equitable decisions concerning risky technologies. Johnson and Scicchitano (2012) studied communities dealing with solid waste siting issues. Although the NIMBY literature casts citizen responses to location decisions in a negative light and portrays them as not based on considered evaluation of information, the study by Johnson and Scicchitano (2012) found that only a few respondents exhibited NIMBY motives and that the respondents' concerns were legitimate, informed by information they had about landfills, and related to their ability to recall the problems and benefits of landfills.. The contents of their concerns related less to selfish motives such as property values and traffic problems, and more to questions of personal health and environmental safety. Furthermore, respondents perceiving that they live close to a landfill are not significantly more likely to emphasise the dangers of landfills (Johnson and Scicchitano 2012).

Kulatunga et al. (2006) found that attitudes and perceptions of the construction workforce can have an impact on the generation and implementation of waste management strategies. The construction workforce has positive perceptions and attitudes regarding minimisation of waste and the conservation of natural resources. Obstacles to proper waste management practices in the industry were related to negative attitudes towards subordinates, differences in attitudes between different working groups and a lack of training aimed at reinforcing waste minimisation practices.

Attitudes towards waste management held by the residential sector may vary spatially within a region, as was evident in a study conducted in Dublin, Ireland. Therefore, it is imperative that differentiated responses be taken into account to avoid waste management initiatives designed for one area and not catering for the needs of other areas in the region (Purcell and Magette 2010).

Educational programmes affect the relationship between attitudes towards solid waste management and recycling motives (Aini et al. 2002). A study conducted in Zhengzhou, China recommended improved education on waste separation to stimulate willingness to separate (Dai et al. 2017). Community education programmes could also improve citizens' attitudes and behaviour in terms of municipal solid waste, as was confirmed by a study on health education in Al Ghobeiry, Beirut (Karout and Altuwaijri 2012) and also

recommended in a study conducted in Tehran, Iran (Nasrabadi et al. 2008).

A study conducted in Conakry, Guinea found households and communities to be careless about waste disposal practices and recommended the promotion of environmental information and education, adoption of community action programmes on disease prevention and health promotion to enhance the comfort, environmental friendliness and safety of the community (Mamady 2016).

A study in Olabisi Onabanjo University, Nigeria (Ifegbesan et al. 2017) confirmed the need for student-focused sustainability education to promote active environmental citizenship. Environmental education should be integrated into programme curricula and non-formal activities to enhance the understanding of the relationship between effective solid waste management practices on campus and sustainable human settlements. The skills, knowledge and disposition acquitted in this way would increase awareness and change the negative perceptions of students (Ifegbesan et al. 2017).

However, education cannot act as a stand-alone measure, as noted in an early study by Mwanthi and Nyabola (1997) on knowledge and attitudes regarding solid waste management in Nairobi, Kenya. Education needs to be combined with the provision of infrastructure to deal with waste and promote a participatory approach (Mwanthi and Nyabola 1997).

Although consumer attitudes are a dominant research theme, and the positive impact of education on attitudes of consumers is confirmed in various studies, Nzeadibe and Ajaero (2011) also highlight the impact of education on the attitudes of informal workers in the waste sector. Education on the contribution of the informal sector serves as a tacit acknowledgement of the work done by waste pickers and increases their perceived self-confidence and attitudes towards their occupation.

In a study conducted in Padang, Indonesia, Ulhasanah and Goto (2018) recommended that readiness for modification in a solid waste system and positive environmental behaviour should be fostered by enhancing the effects of law enforcement and environmental knowledge as a preliminary step before modifying the solid waste banking

system. The modified system is comprised of three components, namely a “fund” for economic benefits (including options such as micro credit finance and a waste credit card as a benefit of belonging to a waste bank), “utilisation” of treatment of waste (using waste to create value by waste banking, conversion to fertiliser, plastic pellets, crafts) and “nurture” for environmental education and encouragement (provision of training and environmental education in waste separation and fun activities, e.g. a children’s park, waste management website, environmental events and games and environmental seminars). The system aims to encourage pro-environmental behaviour and to accustom citizens to waste separation. In addition, it could also empower citizens to facilitate collaboration with local governments in the management of municipal solid waste. The authors also note that this system can be useful to other developing countries.

2.7 Willingness to pay (WTP)

Some authors argue that in developing countries adequate waste management services must require users to carry the full cost of service (Boadi and Kuitunen 2003). Murad and Siwar (2004) also recommend that citizens in Kuala Lumpur, Malaysia be requested to pay a realistic fee for better waste management services.

A factor that influences willingness to pay for separate waste collection services is age (Mwanza et al. 2018b). Apart from age, it is income, number of children, quantity of waste generated and education that significantly affect WTP (Awunyo-Vitor et al. 2013). In the study conducted by Awunyo-Vitor et al. (2013) in Kumasi, Ghana, the amount households were willing to pay was influenced by income, quantity of waste produced, education, house ownership and the number of children in the household. In another study conducted in four major metropolitan cities in Ghana, Boateng et al. (2019) identified factors that predicted WTP. These included educational level, marital status, type of employment and region of residence. Women with senior high school, post-secondary and tertiary education were more willing to pay than women without formal education. This correlation between increased willingness to pay and education level was also noted in a study conducted in Macau (Song et al. 2016). Income, education, age and methods of disposing of waste available to the household were factors influencing willingness to pay for improved solid waste management in Eldoret, Kenya (Sumukwo et al. 2012). In a study in Hong Kong more than one third of the residents expressed their unwillingness to

pay the minimum waste charge (Yeung and Chung 2018). The Hong Kong study indicated that key factors affecting WTP include knowledge of residents about when landfills will reach capacity, degree of support for waste charge policy, amount of daily waste disposal, age and income (Yeung and Chung 2018). Yeung and Chung (2018) recommend strong and rigorous promotional and educational programmes to increase knowledge and improve attitudes towards recycling and they three proposed policies (waste charging, landfill extension and the development of new incinerators). They also suggested that low-income groups should be subsidised as far as the waste charge is concerned (Yeung and Chung 2018). In Macau the majority of respondents were positive about WTP and the probability for positive response increased with education level (Song et al. 2016a & b).

In a study conducted in Eldoret, Kenya, WTP was influenced by income, education, age and total disposal methods available to the household. The amounts residents were willing to pay indicated that they favoured improved waste management (Sumukwo et al. 2012). Residents in Blantyre, Malawi also displayed a willingness to pay for solid waste management services with distance from disposal facilities being a significant factor. Higher income, younger age, higher education level all affect WTP (Ndau and Tilley 2018). Another determinant of WTP apart from income, age and education level, namely quantity of waste, was included in a study on WTP in Colombo 15, Sri Lanka (Addrell and Gunawardena 2020). Similarly, Ayenew et al. (2019), in a study conducted in Shashemene Town, Ethiopia, included the amount of solid waste generated as a determinant but also added bid value. As the bid amount was increased, the WTP decreased (Ayenew et al. 2019). In another study in four regional capitals in Ghana (Accra, Takoradi, Kumasi and Tamale), predictors of WTP included educational level, marital status, type of employment and region of residence (Boateng et al. 2019). Respondents in the study indicated that low income, economic reasons, inadequate collection frequency by waste management companies and the notion that government should pay for service delivery as well as poor service delivery in general were reasons for a lack of WTP. Any form of education was associated with higher WTP. The findings of a study in the City of Huancané, Puno, Peru by Quispe Mamani et al. (2021) indicated that education level, income, perception of generated pollution due to waste and the hypothetical price and satisfaction level with the solid waste management service were

factors influencing WTP. In a study conducted in Kuala Nerus subdistrict in Terengganu and Jelutong subdistrict, Northeast District in Penang, Malaysia, WTP was affected by monthly income, awareness of recycling, frequency of recycling involvement in the first district and gender, age, amount of last donation to a special fund for improved solid waste management services and frequency of involvement in recycling in the second district (Idris et al. 2021). Apart from household income, employment and house ownership affected WTP in a study conducted in Jolarpettai municipality, Tamil Nadu, India. A study of the WTP of Ugandan residents revealed that higher income and larger household size increased WTP for improved waste management services (Otai 2020). However, when respondents were already paying for services or had received waste management information, they exhibited a lower WTP. Age and gender did not influence WTP in this study.

The willingness of contractors to pay for improved construction waste collection and disposal services are influenced by type of company, years of experience in construction, contractor's size category, paid up capital, frequency of existing waste collection, source reduction practices and satisfaction levels regarding the existing waste collection and disposal services. There is an increase in willingness to pay if the company size category and paid up capital increase (Begum et al. 2007) A study conducted in Malaysia, by Begum et al (2007) found that government intervention for the sake of improved waste collection and disposal can take place through a gradual increase in landfill charges. Consequently, contractors will take measures to recycle.

Willingness to pay for landfill mining as a means to conserve resources, energy and land was tested in a rural district of Greece. Damigos et al. (2016) found that although more than 95% of the respondents recognised the need for these programmes, only 25% of the respondents were willing to pay by means of increased tax.

Aguadze (2020) found that preferences for particular payment channels expressed in WTP studies should be taken into account. In the study conducted in New Juaben Municipal Assembly, Ghana, more females indicated other forms of payment such as mobile money as their preference to pay for waste management service.

2.8 Barriers to waste management

2.8.1 Financial barriers

Waste management is quite costly in developing countries as a result of increased waste generation related to a growing population as well as an expanding economy, urbanisation and improving living standards (Filho et al. 2016). In terms of waste management, waste collection, transfer and transport account for between 20% and 95% of the total solid waste management budget. Waste management also involves high per capita infrastructure costs in Small Island Developing States such as Curacao because of the small size of the islands, high tourist impact on the environment and diseconomies of scale (Fuldauer et al. 2019).

A deficit in financial capacity has a detrimental effect on municipal solid waste management (Hettiarachchi et al. 2018). Financial support from national governments and external funding are lacking (Filho et al. 2016; Yukalang et al. 2017) and, moreover, users may not be willing to pay for services or be able to pay user fees for waste collection (Filho et al. 2016). Inhabitants of poorer neighbourhoods often pay higher collection prices for private providers because of the higher costs based on difficulty of access to neighbourhoods, or economies of scale issues, or as a result of a lack of competition between providers (Hernández et al. 1999).

An inability to collect revenue for services rendered because of an absence of infrastructure to collect fees also hampers waste management (Hettiarachchi et al. 2018). Hettiarachchi et al (2018) report that only 65% of Latin American and Caribbean municipalities bill for services. Deficits in revenue also impact negatively on planning for capital investments such as tools and equipment for better service delivery, better waste treatment technology and the enhancement of safety as well as human resource capacity (Hettiarachchi et al. 2018).

Economic instruments are not used properly in developing countries. Gate fees in Greece, for example, were too low to cover good landfill operation, monitoring and aftercare. Gate fees should also be raised to pay for the installation of small-capacity waste treatment units (Boemi et al. 2010). In a study conducted in Thailand the waste

management fee collection proved to be et al problematic (Yukalang et al. 2017). Furthermore, budgets do not make adequate provision for waste management, modernisation, optimisation, capacity building or maintenance, and waste management plans are not implemented fully (Filho et al. 2016).

The assumption that waste has no value was also highlighted (Yukalang et al. 2017).

2.8.2 Infrastructure

A study conducted by Filho et al (2016) indicates that poor infrastructure and a lack of collection equipment present a barrier to the development of waste separation programmes. This includes a lack of enough waste containers and other collection means, a lack of space for waste containers, narrow roads, steep gradients, unsurfaced roads unsuitable for use by standard collection vehicles. A lack of space for waste disposal has also hindered waste management progress in Small Island Developing States (SIDS). In terms of domestic infrastructural problems, South African households in urban areas report a lack of sufficient space to recycle and inconvenient recycling facilities (Strydom 2018). A study conducted in rural areas in the Western Cape also highlighted inappropriate storage as a challenge (Van der Merwe and Steyl 2005). A study conducted in Thailand indicated that space limitations were an obstacle. Other infrastructural issues identified by respondents were a lack of waste collecting points, limited access to waste bins and improper waste separation facilities (Yukalang et al. 2017). Underdeveloped infrastructure also contributed to stalled progress in waste management in SIDS (Fuldauer et al. 2019). Moreover, in Europe and most of the developed world aged or outdated infrastructure related to insufficient maintenance and the inherent limitations of applied technologies present a challenge. This is exacerbated by the requirements of the circular economy (Kirkman and Voulvoulis 2017). Another tendency that inhibits innovation and change in waste infrastructure is the focus on mere regulatory compliance to meet targets and avoid fines rather than on sustainability. Kirkman and Voulvoulis (2017), for example, note how processed waste was exported since it was the cheapest option to ensure compliance. In addition, allowing outsourcing of services with concomitant reduced involvement can stunt the development of infrastructure. Jaccoud and Magrini (2014) indicated that the option of outsourcing and the attendant reduced involvement of port authorities did not stimulate the establishment

of port installations to receive wastes and thus defeated the goals of the MARPOL Convention 1973/1978 and Brazilian legislation.

Resistance to infrastructure development due to potentially detrimental health and financial concerns also presents a challenge. It also delays the planning approval of new facilities. Hence, public perceptions play an important role in waste management decision making: it affects the infrastructure that can be put in place and the success of the implementation (Kirkman and Voulvoulis 2017). This is also confirmed in a study conducted in Kisumu, Kenya where skips were placed at waste transfer points, but without the collaboration of the community or informal waste pickers. The skips rusted, were not of a suitable number and size, and were not replaced. In addition they were not emptied successfully and were vandalised or stolen. Currently the areas where skips were located have become informal dumps and serve as secondary collection points for waste picker entrepreneurs (Kain et al. 2016).

2.8.3 Technological barriers

Developed countries utilise advanced waste management technologies bolstered by government investment in solid waste management. In less developed and developing countries cheaper waste disposal technologies are used because of the lack of or inadequate government investment (Mmereki et al. 2016). Filho et al. (2016) point to the difference in waste types generated in developed and developing countries, the volume and applied treatment and composition as reasons for the ineffectiveness of imported technology solutions. Moreover, advanced technologies (for example, vehicles, equipment for collection, treatment and disposal) are experienced negatively in developing countries, since they are not suited to local conditions. Adaptation to requirements of the context and additional resources for adaptation as well as human resource capacity are needed (Boemi et al. 2010; Filho et al. 2016). For example, in countries with underdeveloped technology, like Greece, technology transfer from other European countries will not provide the answer.

2.8.4 Social and political barriers

Some barriers to solid waste management such as population growth are difficult to address. In some instances, budget allocations only cover permanent residents and non-

permanent residents are not taken into account, as indicated by a study conducted in Thailand (Yukalang et al. 2017). Lack of political will is widespread in Latin American countries in terms of the pursuit of integrated waste management plans, although these are necessary for the business sector (Filho et al. 2016). Lack of decision making on the construction of solid waste management facilities because of their financial and political cost, and lack of motivation or awareness, proved to be a challenge to the government in Greece. Funding was also not used to develop more integrated solid waste management solutions, but spent only on new landfills and transfer stations. Effective coordination among all levels of government in solid waste management also presents a challenge, as is evident from the findings of He et al. (2018) in a study on policy-making coordination. They concluded that weak coordination between policy subjects can be related to “fragmented authoritarianism”, which leads to inter-ministerial competition and power struggles, even though the coordination of policy tools may be strong (He et al. 2018). Local governments also lack flexibility and, along with bureaucratic procedures, this results in delays. Construction of solid waste management plants are also met with negative responses complicated by political interests (Boemi et al. 2010). In a study in Thailand respondents also perceived that politicians feared making unpopular decisions about waste disposal sites because it could hamper their re-election (Yukalang et al. 2017). The legal status of solid waste management authorities needs to be modernised and their human resources need to be improved. In particular this is necessary so that cost-efficient gate fees can be applied, long- and medium-term business plans can be developed, participation in EU-funded projects can be successful, collaboration with other local authorities and public private partnerships can be enhanced (Boemi et al. 2010).

2.8.5 Planning

Although there may be waste management plans in existence, their application and implementation are not guaranteed (Filho et al. 2016). A study conducted in Thailand indicated that a lack of or poor planning was identified as a challenge (Yukalang et al. 2017). In a comparative analysis of solid waste management in developed, developing and lesser developed countries Mmereki et al. (2016) concluded that not enough time is spent on the development of solid waste management plans. Plans ought to be clear, comprehensive and cohesive, and they require integrated design and philosophies for transformation and sustainable implementation. Developed countries seem to perform

well in this regard (Mmereki et al. 2016).

A fragmented approach to planning in general, such as unplanned and unstructured expansion of urban areas, has a negative impact on logistics and subsequently also on the provision of municipal solid waste management (Hettiarachchi et al. 2018). In SIDS a fragmented approach to planning did not allow for stakeholder target setting and envisioning of sustainable outcomes and this caused a disconnect between infrastructure development management and users (Fuldauer et al. 2019).

Since waste management is such a complex issue in urban areas, and particularly in developing countries, a coherent waste planning and waste management policy is crucial. Dos Muchangos et al. (2015) conducted a study in Maputo, Mozambique and differentiated between influential/causal and dependent/affected barriers to be taken into account when decision makers design effective policy improvement strategies. The authors recommend that the former should be prioritised, because they have an important influence on waste policy and can be considered as the root causes of the second group of barriers. Influential barriers include weak waste management institutional structures, inadequate application and enforcement of the law, political interference and the absence of effective mechanisms to encourage active involvement from other stakeholders. These all amount to governance challenges. If such governance challenges can be addressed, a number of practical measures should be implemented to achieve economic sustainability; these include effective waste handling technology, effective education to influence behavioural change, introducing robust monitoring procedures as well as information and performance assessment systems, promoting voluntary initiatives and public participation to enhance a sense of ownership, and including community-based programmes in the waste policy (Dos Muchangos et al. 2015).

2.8.6 Administration

Solid waste management administration presents challenges that must be addressed in developing countries as part of a holistic approach, including monitoring and assessment of waste management programmes (Mmereki et al. 2016).

Government oversight is necessary to address health threats related to the environment,

but in developing countries this is costly and is often absent (Martinez and Bowen 2012). A case in point is the Nejapa project entailing a Clean Development Mechanism validated greenhouse gas emissions reduction plant on the landfill in El Salvador. There are no regulations which dictate air and water quality measurement and the community reported a variety of health related problems (Martinez and Bowen 2012). Moreover, since there was no legislation or oversight, accountability for the promised social commitment presented a challenge (Martinez and Bowen 2012).

2.8.7 Capacity

Institutional capacity is stronger in developed countries compared to developing countries (Mmereki et al. 2016). Mmereki et al (2016) highlight aspects such as leaders' interest, budget, accountability, poor policy performance, transparency, management structures and commitment of local authorities as institutional weaknesses. Hettiarachchi et al. (2018) and Boemi et al. (2010) add that waste management in developing countries is hampered by the lack of knowledge about treatment systems, as well as lack of technical skills and organisational capacity. Local authorities do not always have the capacity to manage natural resources and to use appropriate measures to address environmental concerns. Some solid waste management facilities in Greece were a case in point, disposing of treatment residues onto land or into water (Boemi et al. 2010).

This lack of skill is exacerbated by the negative associations with the profession of solid waste management and waste workers (Filho et al. 2016). These authors further point out that in some parts of Latin America working in solid waste management is not viewed as honourable. Consequently, there is a shortage of personnel skilled in waste management in municipalities and this deficiency intensifies the inability of municipalities and communities to launch new projects to modernise and optimise waste management.

2.8.8 Engagement and participation

Limited collaboration between stakeholders is one of the reasons behind ineffective management of solid waste (Mmereki et al. 2016).

In a study conducted in Thailand, lack of participation was signalled by lack of engagement in waste separation activities, the failure to attend community meetings on

the management of domestic waste, and ignoring anti-litter signs. Moreover, there was also a lack of cooperation between stakeholders like the local government and important institutional role players (Filho et al. 2016; Yukalang et al. 2017). Lack of scientific knowledge and information guidance hindered public participation and engagement with MSWPs in China. As He et al. (2018) concluded, public participation is merely tokenistic and consequently encourages the public to think that municipal solid waste problems are the duty and responsibility of national governments and that the public are not expected to contribute. A lack of cooperation was also highlighted as a major factor that can contribute to poor waste management policy performance, as indicated by a study conducted in Maputo City, in the Republic of Mozambique (Dos Muchango et al. 2015).

The integration and formalisation of the participation of the informal sector is important due to the contribution this sector makes to waste disposal in BRICS countries (Gonçalves et al. 2018). Filho et al. (2016) also confirm that the informal waste collectors and recyclers play a pivotal role in the value chain, but that authorities do not recognise their potential. The informal sector can enhance the success of sustainable waste management in developing countries. Therefore, legal recognition of waste pickers and collaboration with all community-based stakeholders are important. The failure to recognise informal recycling networks has, for example, been an issue in Ecuador (Hernández et al. 1999).

A study conducted in Botswana (Bolaane 2006) confirmed that recycling initiatives do not take into account the perceptions and attitudes of municipal officials and the public towards recycling schemes. In spite of the recycling awareness of these key stakeholders, municipal officials in Gaborone do not embrace waste management reforms, nor do the public participate in recycling initiatives. Constraints hindering municipal officials from participating in reform include limited human, transport and financial resources, the small likelihood of self-financing organised recycling, and the limited knowledge and practical experience of municipal officials. Public participation was limited by weak direct economic incentives and the absence of visible recycling centres. In addition, the public tend to favour separating out materials with known markets and noteworthy financial value. To enhance awareness and public participation in recycling in Gaborone, public education and direct incentives must be utilised. Multiple stakeholders must also be involved

including NGOs, households, and the private and public sectors. Bolaane (2006) also noted that limitations hindering the acceptance of reform measures among municipal officials included stagnant attitudes, knowledge and practical experience, which decrease the likelihood of the promotion of people-centred approaches.

2.8.9 Structure and systems

Mmereki et al. (2016) highlight the lack of adequate institutional structures as one of the main weaknesses of solid waste management in developing countries.

Management of solid waste necessitates efficient structures (Gonçalves et al. 2018). In particular, management of solid waste necessitates efficient administrative and technical-operational structures (Gonçalves et al. 2018) Moreover, services need to be decentralised with clear role and responsibility allocations. Institutional structural weakness can contribute towards poor waste management policy performance, as indicated by a study conducted in Maputo City, in the Republic of Mozambique (Dos Muchango et al. 2015).

2.8.10 Inappropriate collection methods

In a systematic literature review on urban solid waste management in BRICS countries Gonçalves et al. (2018) concluded that the collection stage of solid waste management and inappropriate storage are challenges. This was also the conclusion regarding cities in developing countries, as indicated by a study conducted in Abuja, Nigeria (Abubakar 2017). A study conducted in rural areas in the Western Cape also highlighted inappropriate collection as a challenge (Van der Merwe and Steyl 2005). Irregular waste collection was raised as an issue in a study conducted in Thailand (Yukalang et al. 2017). Another related challenge in Thailand is caused by inadequate waste collection vehicles that have to transfer large volumes of waste over a significant distance to the landfill site (Yukalang et al. 2017).

Traditional collection practices remain commonplace in many countries in Latin America and the Caribbean. Formal separation for recycling is practised on a small scale and formal means of recycling account for only 2% of the municipal solid waste management methods. Consequently the volume of recyclables ending up in landfills and dumps is

quite large. In addition, organic content which can be used for compost or biogas production can generate revenue (Hettiarachchi et al. 2018).

2.8.11 Inappropriate disposal

Gonçalves et al. (2018) indicated that irregular disposal presents a challenge in BRICS countries. A study conducted in rural areas in the Western Cape also highlighted inappropriate disposal strategies as a challenge. Disposal sites were not strategically located, nor were they appropriately constructed or operated (Van der Merwe and Steyl 2005).

2.8.12 Awareness

Certain populations show a general awareness of waste problems, as found by Tartiu (2011), who conducted a case study among students at the Bucharest Academy of Economic Studies. However, these students requested more information, updates and reminders about waste management practices. In particular the knowledge and awareness of decision makers in BRICS countries needs to be improved (Gonçalves et al. 2018).

A lack of public awareness, motivation and education as well as a lack of consistent efforts to raise awareness on the benefits of waste separation were among the reasons listed for non-compliance in cities in India (Joseph et al. 2012).

The lack of knowledge of the public hinders public participation, as was found in China as the public is not provided with details of MSWPs (He et al. 2018). Kirkman and Voulvoulis (2017) also confirm that the public need a basic understanding of science, its achievements and limitations, since virtually all public policy issues have scientific or technological implications. Citizens must also be able to make informed decisions. Ultimately, an increase in knowledge could enhance public communication, engagement and participation.

A lack of knowledge not only hinders public participation in planning and decision-making, but also participation in household waste management. Strydom (2018) also found a lack of knowledge of recycling in South Africa households. In a study conducted in Thailand,

poor communication on waste management facilities, lack of information and distribution of information via inappropriate media contributed to a lack of awareness and consequently engagement (Yukalang et al. 2017).

2.8.13 Attitude

Urban South African households associate dirtiness and untidiness with recycling and consequently their attitude to the practice presents a barrier (Strydom 2018). In Thailand residents, entrepreneurs and local municipality staff displayed negative attitudes towards recycling and waste management. Negative attitudes included lack of concern for waste management, blaming others for bad waste management practices and a perception that effective waste management presents an unsolvable problem (Yukalang et al. 2017).

2.8.14 Risks

Since solid waste management practices involve manual handling tasks, the occupational risks, in particular muscular-skeletal disorders, and other safety and health risks such as diarrhoea, viral hepatitis and obstructive and restrictive disorders present a barrier to solid waste management. These hazards also have a major impact on informal waste collectors as is evident from a study conducted in the informal sector of Gweru, Zimbabwe (Jerie 2016) and a South African systematic literature review (Schenck et al. 2016).

A study conducted in Tanzania and Zambia (Foster et al. 2012) pointed out that women employees in waste management collecting waste or sweeping streets face health risks due to exposure to hazardous waste. In most cases protective gear was lacking. In addition, street sweepers are exposed to risks caused by traffic and dangerous conditions when they are sweeping streets at night (Foster et al. 2012).

2.8.15 Legislation and policy

Earlier literature on developed countries such as New Zealand and the USA revealed problems with initial waste management legislation (Boyle 2000; Clark et al. 2006). Pertinent were a lack of coordination on national level leading to inconsistent waste management standards (Boyle 2000). A review on construction and demolition waste in the USA (Clark et al. 2006) also confirmed that a lack of federal definitions or management for a specific waste stream leads to inconsistent definitions and regulations,

which may indicate uncertainty about the environmental risks associated with certain types of waste. For example, Clark et al. (2006) suggested that inconsistent liner and groundwater requirements might signal a lack of clarity about the environmental risk of construction and demolition waste in landfills. The authors recommended that federal regulations or guidance could address these concerns and provide standardised environmental protection, particularly for landfills. The study also emphasised that legislative review is prompted by progressive information about the effects of certain waste streams. Legislative review may also be necessary where it must be aligned with requirements in subsequent general legislation on solid waste management, for example, the Solid Waste Management Plan relating to Brazilian Ports (Jaccoud and Magrini 2014). Apart from coordination problems, a plurality of legislation originating from different entities can also create a complex regulatory framework that is difficult to apply. The Brazilian legislation and regulations on port solid waste management provides an example (Jaccoud and Magrini 2014).

Other issues include policy hindering coordination, ineffectiveness of legislation in managing waste and curbing pollution, lack of legislation on or vagueness regarding specific areas, e.g. hazardous waste (Boyle 2000).

In many developing countries legislative documents, policies and regulations reflect those in developed countries. Filho et al. (2016) list the “Rules on Waste Separation at Source” in Thailand, “Solid Waste and Public Cleansing Management Act 2007” and “Solid Waste and Public Cleansing Management Corporation Act 2007” in Malaysia, the “Law on the Prevention and Control of Environmental Pollution by Solid Waste 2005” and “Standard for Pollution Control on the Landfill Site for MSW 2008” in China as examples. Inadequate legislation was also noted as a barrier in a study conducted in Thailand (Yukalang et al. 2017). In addition, non-operational laws and policy increase waste generation (Bello et al. 2016). Furthermore, the implementation and consistency of waste policies and weak enforcement present a global challenge (Mmereki et al. 2016; Filho et al. 2016; Yukalang et al. 2017). For example, in Indonesia, Cambodia and Vietnam law enforcement is lenient and lacks political support (Filho et al. 2016) The absence of practices and policies and ineffective enforcement have a detrimental effect on planning (Mmereki et al. 2016; Yukalang et al. 2017). Greece, for example, suffered from a lack of mechanisms to control

compliance with water regulations (Boemi et al. 2010). In the SIDS a lack of regulations and poor planning also hinders progress in waste management (Fuldauer et al. 2019).

Legislation and policies also need to be evaluated in terms of the inhibiting effect they could have on collaboration with the private sector. Bello et al. (2016) point out that private actors with adequate resources who are willing to participate in waste management have been prevented from doing so by some by-laws which relegate all waste management responsibilities to the government.

2.9 Approaches to management of solid waste

2.9.1 Introduction

According to Mohee and Bundhoo (2015), integrated solid waste management seems to be the popular approach to waste management. Somaroo and Gukhool (2015: 218) define it as “the selection and application of suitable techniques, technologies and management programmes to achieve specific waste management objectives and goals”. The six key functional elements of integrated solid waste management system are (1) waste generation, (2) waste handling, separation, storage and processing at source, (3) waste collection, (4) transfer and transport, (5) waste separation, processing and transformation and (6) waste disposal (Mohee and Bundhoo 2015). Waste management strategies address these elements but are subject to a preferred hierarchy which ranks in order of priority (1) source reduction, (2) recycling, and (3) waste transformation and disposal (Somaroo and Gukhool 2015). In the following overview of approaches to the management of solid waste, the six key functional elements and waste hierarchy will be used as organisational principles in conjunction with other categories that emerge in the literature.

2.9.2 Waste prevention and generation

2.9.2.1 Scope of waste generation

Aguadze (2020), drawing on Momoh and Oladebeye (2010) defines waste generation as those activities prompted by the identification of materials as without value by discarding them or gathering them for disposal. Although the following statistics and projections are not comprehensive, they give an indication of the waste generated in the Global South,

North America and Europe. In America in 2013, 254 million tons of waste was generated – or 2 kg of waste per person per day (Mozo-Reyes et al. 2016). In 2010 the daily municipal solid waste volume generated in Latin America was estimated at 436 000 tonnes, which amounts to 0.93 kg/person/day. However, Uruguay at 0.11 kg/person/day, and Bolivia, at 0.33 kg/person/day deviated from the average and had the lowest generation rates. Conversely, Guatemala exceeded the waste generation rate per person, averaging the highest rate in the region of 2 kg/person/day (Filho et al. 2016). In a study conducted in 2018 which included the Caribbean, municipal solid waste amounted to 1.09 kg/capita/day (Hettiarachchi et al. 2018), which was comparable to waste generated in Eastern Europe and the MENA region, but higher than the rate in Africa and lower than the rate of the OECD. The developing country with the highest volume of municipal solid waste compared to other countries is China. The total volume of municipal solid waste amounted to 179.36 tons in 2011 and is expected to increase to 480 million tons in 2030 (He et al. 2018).

In the Baltic States (Estonia, Latvia and Lithuania), the new EU members, the amount of municipal waste generated was much less at 450 kg/person/year compared to other more developed EU states (Filho et al. 2016).

2.9.2.2 Factors impacting waste generation

In a study by De Morais Vieira and Matheus (2018) conducted in Brazil rurality was not a significant factor linked to waste generation. Size of population did not have an impact on municipal solid waste generation. Significant factors were education and economic status (income per capita had the second highest correlation with waste generation). However, the factor that had the highest correlation with waste generation was inequality. De Morais Vieira and Matheus (2017) note, with reference to Dorling (2017), that levels of inequality also impacted on municipal solid waste management in high-income countries. This correlation between municipal solid waste generation and high inequality can be ascribed to the stimulation of consumption and the subsequent waste production in societies with higher inequality (De Morais Vieira and Matheus 2018). Conversely, countries with less inequality such as Sweden and Japan had higher recycling rates. However, De Morais Vieira and Matheus (2018: 83) caution against the use of inequality as an independent factor: “Inequality ultimately complements income or other economic status; it

summarises income distribution in society and social dynamics that encourages waste generation, limits access and hinders policy implementation. Inequality must not be used by itself ...”. Ultimately, unequal conditions may be addressed by differentiated policies, e.g. differentiated taxes.

2.9.2.3 Historical research trajectory

The focus on waste prevention in research during the latter half of the twentieth century was promoted by the increase in waste during the past century. In addition, waste treatment and disposal became more expensive. Initially, research concentrated on the role of waste prevention activities and highlighted the benefits of waste prevention, namely, cost savings, litter prevention, conservation of natural resources and the reduction of the negative effects of consumption on the environment (Hutner et al. 2017). Waste characterisation studies have become more prevalent and bring waste generation into the spotlight.

2.9.2.4 Definition of waste prevention

In terms of the waste hierarchy, waste reduction has precedence (Hutner et al. 2017). However, the emphasis has mostly been on recycling and enhanced waste disposal management, goals that contribute to but that are not themselves sufficient to achieve long-term sustainability (Cecere et al. 2014). As Cecere et al (2014: 164) note, “the real objective should be to reduce the amount of waste being produced, in both relative and absolute terms”. Achieving this objective is challenging because targets on waste prevention are fairly recent, and the economy does not prioritise achieving environmental goals ((Hutner et al. 2017; Cecere et al. 2014). Waste prevention is expensive and involves far-reaching changes in behaviour and life styles (Cecere et al. 2014).

Karbalaei et al (2013) define the waste prevention behaviour as people’s purchasing behaviour that is difficult to change, and their preference to use personal and reusable items instead of disposable items. This definition is reminiscent of other formal and conventional definitions employed by, for example, the Organization for Economic Cooperation and Development (OECD) and the European Waste Framework Directive (Corvellec 2016). In terms of the OECD definition waste prevention takes place before products or materials can be labelled as waste and encompasses the reduction of the

quantity and hazardous nature of the latter, waste avoidance, “material and product reduction at source, or reuse. Recycling, however, is also categorised as waste minimization. The European Waste Framework adds the action of product life span extension and emphasises the reduction of negative consequences on the environment and human health (Corvellec 2016).

In practice, the notion of waste prevention is wider in scope than the conventional definitions. The broader conceptualisation of waste prevention encapsulates the product lifecycle as a whole, and recycling plays a role since it reduces waste at landfill and also entails the extraction of raw materials (Corvellec 2016). In terms of general consumer perspectives, households perceive recycling as prevention and the terms waste ‘prevention’, ‘reduction’, or ‘minimisation’ are used interchangeably. Different countries also use various definitions of waste prevention and may, for example, include or exclude composting as a waste prevention action. Based on this discrepancy between formal definitions and conceptualisation in practice, Corvellec argues for a performative definition of waste prevention that is more reflective of a changing and diverse context and a “multisided social change process” (Corvellec 2016: 9). Following an analysis of 51 Swedish waste prevention initiatives, he concludes that waste prevention mainly encompasses three activities: “raising awareness about the need to prevent waste, increasing material efficiency, and developing sustainable consumption” (Corvellec 2016: 6). Although a wider conceptual approach to waste prevention (e.g. in terms of the performative definition discussed above) allows greater sensitivity in addressing a changing and heterogenous context, waste prevention behaviours should be distinguished where motivation is concerned. Not all behaviours associated with waste prevention are driven by the same factors and might in fact be associated with opposing motivations, for example, waste reduction and recycling (see, for example, Cecere et al. 2012).

Hutner et al (2017) schematized types of waste prevention within the framework of the phases of the product life cycle. In the pre-use phase reduction at source and substitution can take place during design and production. Consumers can also substitute products with alternatives that comply with the requirements for waste prevention, if the product is available through retail. Intensification (e.g. sharing, prolonged or exhaustive use through

repair, donation and change in consumption patterns) is a waste prevention measure during the use phase. During the end-of-use phase users can opt for lifetime extension by reuse (which may include checking, cleaning, repairing and remanufacturing) (Hutner et al. 2017).

2.9.2.5 Benefits of waste prevention

A modelling study based on a lifecycle perspective indicated that waste prevention does not have a major direct impact on the environmental profile of waste management systems unless avoided production is taken into account (Gentil et al. 2011). Food waste prevention results in the largest environmental impact saving and, as far as low-tech systems depending on landfilling are concerned, prevention leads to more benefits compared to high-tech waste management systems based on high energy usage and material recovery (Gentil et al. 2011).

2.9.2.6 Barriers to waste prevention

Some researchers have concluded that general waste prevention attempts and the reduction of collected municipal waste are unsuccessful (Wiesmeth et al. 2018, with reference to Tencati et al. 2016 and Andersson and Stage 2018). Research indicates that the implementation of waste prevention measures has been challenging because of the lack of environmental awareness, the lack of incentives to drive action, inadequate data, the reduced importance of repair and reuse ascribed to shortened innovation cycles, product devaluation in modern society and the conflation of waste prevention and recycling by consumers (Hutner et al. 2017; Johansson and Corvellec 2018), lack of knowledge, standards, resources, social norms, financing, organisational capacity and lack of waste management (Johansson and Corvellec, 2018). Since research on policy seems to be scarce, it is difficult to gauge the effect of policy on the implementation of waste prevention strategies (Johansson and Corvellec 2018).

The literature indicates that the current consumption patterns of consumers, the lack of information and awareness, and concerns about the effectiveness of waste prevention measures, high costs of implementation, negative consequences for industry and the conflation of waste prevention and recycling are barriers to the implementation of effective waste prevention strategies. Hutner et al (2017), in a study on waste prevention in

Bavarian municipalities, differentiate between seven potential barriers, consisting of soft and hard barriers, complemented by a miscellaneous category of other reasons. Hard barriers include high financial costs, inadequate availability of personnel and resources, and legal restrictions. Soft barriers include low acceptance, unknown or unrecognised waste prevention measures and ineffective waste prevention activities. Reasons for low acceptance included lack of general environmental awareness, lack of motivation to engage, and concerns about existing conflicts of interest. Motivational issues include scepticism about the validity of waste prevention as an option for local authorities that rely on paper and plastic as secondary resources, lack of economic and legislative incentives, and the insecurity of recognition of individual contributions. Where conflicts of interest are concerned, waste prevention may conflict with political agendas and the design of the current societal and economic system (Hutner et al. 2017).

2.9.2.7 Perceptions of waste prevention, generation and diversion

Benyam et al.(2018) examined perspectives on the generation, diversion and prevention of domestic food waste with the aim of informing local government policy. Consumers faced with choices between home/backyard composting, community composting, residential food waste collection programmes and prevention options entailing education programmes to prevent over-purchasing and over-consumption expressed a preference for home / backyard composting and education.

2.9.2.8 Causes of waste prevention

A categorisation of the causes of waste prevention behaviour highlights four aspects: attitudinal, contextual factors, personal capabilities and habits, and routines (Bortoleto et al. 2012).

2.9.2.8.1 Motivation to participate in waste prevention, minimisation and recycling

Although the packaging industry and economic factors have an impact on waste reduction, individuals play an important role in waste prevention by reducing consumption and reusing, reselling or sharing products (Karbalaee et al. 2007; Cecere et al. 2014).

Until recently there was a dearth of literature on waste prevention behaviour (Bortoleto et al. 2012; Karbalaee et al. 2013; Corsini et al. 2018). Some studies focused on accepted

reduction-reuse behaviours (Bortoleto et al. 2012) and have a limited scope, concentrating on specific problematic issues such as marine litter (for example Gusmerotti et al. 2016), cited by Corsini et al 2018 and food waste (for example Queded et al 2013, cited by Corsini et al 2018). Other older studies address incentives and the potential for the reduction of municipal solid waste (Wiesmeth et al. 2018), the benefits of waste prevention (Wiesmeth et al. 2018). Further research related to waste prevention behaviour is important because it might indicate how to increase waste prevention activities and how to shape policies and strategies into more effective tools (Corsini et al. 2018).

Earlier studies on waste prevention behaviour highlighted environmental values, attitudes with an emphasis on moral obligation and concern with respect to the environment, and the notion of active citizenship centred on rights and responsibilities, acceptance of personal responsibility, awareness and need (Bortoleto et al. 2012). Bortoleto et al. (2012) also examined which factors significantly impact waste prevention behaviour and concluded on the basis of a model of prevention constructed by merging attitude-behaviour theories that personal norms and perceived behaviour control are the main predictors.

Personality traits, cognitive styles and emotional intelligence play an important role in predicting waste prevention behaviours (Abdollahi et al. 2015; Karbalaei et al. 2013). In particular, greater hardiness, emotional intelligence, internal locus of control, and higher age were good predictors of positive waste prevention behaviours in university students and should be utilised in the construction of environmental theories and models; this would have a positive impact in programmes including behavioural modification and interventions (Abdollahi et al. 2015). In addition to locus of control, effective problem-solving confidence, approaching style and personal control style predicted better waste prevention behaviour (Karbalaei et al. 2013).

Corsini et al. (2018) studied the determinants of specific waste prevention behaviours, namely the avoidance of buying products that are disposable or that have excessive or unnecessary packaging, or the decision to repair items to increase their lifespan. In terms of the five determinants of behaviour explored (awareness about the consequences,

personal norms, attitude towards waste prevention, perceived behavioural control, and social norms) they found that awareness of consequences is an important determinant of waste prevention behaviour and confirmed a positive relationship between attitudes and behavioural control.

In economics literature researchers have also in the past decades explored how household behaviour has influenced and can influence diversion of waste from landfills. This shift in acknowledging the significance of non-monetary motivations of human behaviour is a response to earlier work done by psychologists and sociologists. In particular, economists started to investigate new models of motivations for interpreting individual actions not premised on the pursuit of self-interest (Gilli et al. 2018). Cecere et al. (2014) investigated the role of intrinsic and extrinsic motivations related to waste management behaviour based on a large EU consumer survey focusing on food waste prevention. They found that intrinsic motivations, and in particular altruistic motivation not automatically correlated with economic incentives or social norm pressure, are significant. In this regard waste reducers differ from recyclers, since the latter might express visible and social green preferences by opting to buy recycled goods. These varied responses should be taken into account where policy interventions are concerned. Waste reducers and recyclers also respond differently to economic incentives. Waste reducers responding to intrinsic motivations can react negatively when a monetary incentive is provided in cases where a previously non-monetary relationship existed, unless the waste reducer is provided with a choice between opting for economic rewards for themselves or monetary support for environmental causes (Cecere et al. 2014). Gilli et al. (2018) confirmed the correlation between intrinsic motivations and minimisation behaviour, but extended the scope of waste streams beyond food waste. Their research also highlighted the difference between recycling and other minimisation behaviour: extrinsic motivation is more relevant where recycling behaviour is concerned and the former increases the likelihood of the latter.

2.9.2.8.2 Demographic and socioeconomic factors

In a study done in Ethiopia demographic factors like age, education, household size and gender did not seem to have a significant impact on waste disposal choices. Increased household income, however, was associated with less illegal dumping, and willingness to

pay informal waste pickers and private workers to carry out waste disposal (Tadesse et al. 2008). In Dhanbad district, in the Jharkhand state of India, the middle socioeconomic group and lower-middle socioeconomic group generated more waste compared to the high socioeconomic group, because the former two groups have more members in a family. In particular, the medium socioeconomic group generates the maximum waste (Khan et al. 2016).

2.9.2.8.3 Policy considerations

Johansson and Corvellec (2018) studied the objectives and measures of European and Swedish national and municipal waste prevention plans, namely the European Commission's Waste Framework Directive (2008), the EPA's Waste Prevention Program that provides guidance to Sweden on national level, and five Swedish municipal plans dating from 2011 to 2016. They concluded that waste prevention objectives and measures do not address consumption as the underlying driver of waste generation. In addition, waste prevention plans focus equally on the improvement of waste handling and waste prevention at source and concentrate on lesser waste streams, in particular on food waste. Measures tend to be soft rather than rigid constraints; they do not provide clarity on incentives and sanctions, and the measures are left to the market rather than the control of planners (Johansson and Corvellec 2018).

2.9.2.9 Strategies to enhance prevention and minimise generation

2.9.2.9.1 Local government

With the increased importance of waste prevention, reliable methods to monitor, measure and evaluate its benefits become vital. Lasaridi et al. (2015) designed a web-based tool (the WASP tool) that enables local authorities to select and implement optimum waste prevention programmes and implement the European Waste Framework Directive. The tool is based on lifecycle thinking and has been tested in two Mediterranean countries, Greece and Cyprus. The tool works with local data such as population and waste production per capita and incorporates local authorities' preferences in terms of the design of their waste management policies and strategic goals.

2.9.2.9.2 Commercial

Measures to decrease waste in commercial environments have been investigated. Nessi

et al. (2014) studied the use of liquid detergents (laundry detergents, fabric softeners and dishwashing detergents) through self-dispensing systems in Italian retail stores by means of a lifecycle assessment. This waste prevention measure proved to be highly effective in eliminating single-use plastic containers but is dependent on an optimal number of uses of refillable containers (10–15 uses).

2.9.2.9.3 Households

Although waste prevention through reduction and re-use is paramount in the waste hierarchy, measuring the amount of waste prevented is challenging. Methods used to quantify waste prevention in households include self-weighing, monitoring or reporting; use of waste collection round data, use of control and pilot groups, attitude and behaviour studies, point-of-sale data and hybrid approaches (Matsuda et al. 2018). Matsuda et al. (2018) monitored waste prevention and recycling activities in Kyoto city. In particular, they measured prevention of plastic shopping bag use, prevention of wasted untouched food and leftovers, prevention of PET bottle use and non-rechargeable batteries. To measure the amount of prevented household waste, they investigated relative change from a baseline year, absolute change from potential waste generation and absolute number of activities. They concluded that setting a baseline is a significant component of waste prevention evaluation and that specific policies or campaigns can be more effectively measured by monitoring relative change from a baseline year. In comparison, when the total impact of waste prevention is measured compared to recycling, the other measurement options should be applied.

One of the most effective measures for the diversion of biodegradable municipal waste from landfill is food waste prevention (Rispo et al. 2015). Globally, food waste amounts to about one third of all food produced and has economic consequences such as unnecessary expense, social consequences, for example, food security issues and environmental concerns such as unnecessary greenhouse gas emissions, extra water consumption, land use and threats to natural biodiversity (Schmidt 2016). The main causes of food wastage differ in developing and industrialised countries. In the former, high amounts of food loss (due to spoilage, excessive quality reduction etc. related to inefficient production and transportation, insufficient knowledge or natural events) is reported before food even reaches consumers. In these countries structural strategies

and technical improvements are recommended (Schmidt 2016). Food waste (i.e. discarding food suitable for human consumption inadvertently or consciously) is associated with the individual behaviour of final consumers in industrialised countries. Furthermore, diverse studies in Germany, Great Britain, Italy, France, Austria, Switzerland and the USA show that private households are the primary contributors to food waste (Schmidt 2016). Consequently, effective food waste campaigns should target consumers' food practices. In particular, the emphasis should be on planning, shopping, storing, preparation and food use and the transfer of best practices, information, education, and food donation to social services (Rispo et al. 2015). On the basis of an environmental psychologically-based intervention aimed at German households, Schmidt (2016) concluded that providing appropriate action knowledge, securing public commitment and using goal-setting can promote household food waste prevention behaviours.

Household food waste behaviour in South Africa seems to mirror patterns in the developed world. In particular, food types wasted by well-educated, high-income white South Africans are similar to waste reported in European households. Reasons reported for food wastage in South Africa show similarities to reasons provided in the UK (Oelofse and Pienaar 2016). A study done in the city of Tshwane concluded that high-income households waste the most food. However, the difference between the food waste generated by low- and medium-income homes is not high. Reasons for food waste reported by respondents included cooking and buying too much food, special offers, fruit and vegetables going off, food residue and poor storage. The main reason seems to be cooking too much food (Ramukhwatho et al. 2016). However, researchers foresee that this cause might be difficult to address since it relates to cultural heritage (Oelofse and Pienaar 2016). Oelofse and Pienaar (2016) also reported that confusion around food labels was reported and addressing this issue may reduce food waste significantly. A recent study by Oelofse et al. (2018) indicated that initiatives to reduce urban households' food waste reduction and diversion from landfill can have a significant impact on landfill waste reduction.

Food waste prevention activities in highly deprived communities in high-density areas are not often studied in developed countries. Rispo et al. (2015) found that food waste

amounted to a small portion of the waste generated by members of this community. Most of the members were willing to participate in a food waste separation scheme and potential food waste segregators differed from non-food-waste segregators in terms of their moral motivations. However, Rispo et al. (2015) point out that this contrasts with a study done in Norway that classified food waste separation as a 'norm-based' activity.

An important consideration in terms of food waste prevention is the rebound effect. When food waste is prevented, households have increased income that could result in expenditure on alternative products and services, which could in turn have other or higher environmental impacts such as additional GHG emissions (Salemdeeb et al. 2017).

2.9.2.9.4 Institutions

Educational institutions represent another important sphere where waste prevention, reduction and consumption is a concern. In this regard, universities have been compared to large commercial concerns (Viebahn 2002 cited in Amutenya et al. 2009). The reduction of specific waste streams has been studied in various educational institutions (for example, Zorpas et al. 2017 (plastic water bottle use in primary schools) and Amutenya et al. 2009 (paper use in universities)). Waste and material consumption should be reduced both for financial reasons and because universities are training grounds for professionals and decision makers. Professional environmental management systems and the implementation of environmental policies have not been optimised in the past. As one of the products that historically make up a large portion of solid waste in these institutions, paper was wasted with minimal re-use. Researchers have investigated how this waste challenge can be addressed. Re-use of paper can be encouraged by printing policies, investing in printers that can print on both sides of a sheet of paper and incentives for minimised paper use, as determined by research done at Rhodes University, South Africa (Amutenya et al. 2009).

2.9.3 Waste handling, separation, storage and processing at source

In earlier studies in some developing countries, for example Tanzania, the maximisation of waste recycling and resource recovery in combination with minimisation of generated waste seems to be the most promising strategy for improving solid waste management (Mbuligwe et al. 2002). Adam et al. (2014) conducted a study in Lagos among private

sector participant operators, regulators and low-income households to gauge the feasibility of implementing source separation. They found that source-separation issues, government enforcement, market segmentation, financial issues and waste disposal issues were perceived to influence service provision. Regulatory executives viewed source-separation as significant in diverting waste away from landfill and to a lesser extent as relevant for the development of the recyclables market. In addition, they perceived it as important for the government's drive for ISW. Some PSP executives noted that collecting separated waste products requires new technology. Perceptions about granting discounts to households who separate their waste and pay waste bills for mixed waste differed. PSPs were not in favour of discounts due to perceived cost and ownership of waste. The presence of a market for recyclables would, however, prompt PSPs to support discounts (Adam et al. 2014).

Participants also related the success of source-separation to the availability of infrastructure such as community drop-off centres, public drop-off centres and environmental advocacy programmes. An important challenge concerning lacking infrastructure involved the availability of accessible roads. This problem was addressed by lighter motorised tricycles and waste containers such as wheelie bins, but PSPs indicated that waste was not stored in these bins, but rather in sacks and discarded plastic containers (Adam et al. 2014).

Apart from airing their views on infrastructure for source-separation, participants also expressed their perceptions about other issues. These included landfill management, socio-economic classification of communities served by PSPs, construction of a refuse transfer loading station in Lagos, enforcement of penalties on nonpaying households and bridging payments paid to operators by Lagos waste management authority (LAWMA) (Adam et al. 2014).

Customers expressed their perceptions of households' willingness to support source-separation. Interestingly the perception analysis revealed that although households express a willingness to source-separate, their willingness varies based on the waste component. A large percentage (81%) were willing to source-separate plastics from their solid waste, paper (79%) and tins and cans (76%). Willingness denoted potential for the

implementation of source-separation. Separating waste into different recyclable categories was not perceived as too difficult. This finding also indicates that public acceptance of source-separation is a feasible expectation (Adam et al. 2014).

Good separate waste collection is not only related to support for the initiative but is also associated with good education and promotion campaigns. When social-marketing communication is used in this regard to promote the adoption of sustainable recycling behaviour, it should be designed based on potential audience analysis. This was confirmed in a study conducted in Aprilia, Latium, Italy, (Del Cimmuto et al. 2014).

Household participation in waste management or resource recovery programmes is influenced by various factors. Social demographic factors that play a role include age, income level, gender, education and household size. In particular, the use of drop-off facilities was affected by household size, education, age and income. In Korea, income and age had an impact on waste management and recycling (Mwanza et al. 2018b). Similarly, in a study on household waste disposal in Mekelle city, Northern Ethiopia, higher household income decreased the probability of illegal dumping as a waste disposal choice. In the same study demographic factors such as age, education and household size did not have a significant bearing on the choice of alternative waste disposal options (Tadesse et al. 2008). Where heterogeneous social demographic factors such as income and education characterise a household, waste reduction can be challenging. An increase in recycling is observed with higher levels of education. There is also a correlation between recycling and demographic factors such as gender, age, income, education and consumption patterns (Mwanza et al. 2018b).

Apart from social demographic factors a study done in Mekelle city, Northern Ethiopia indicates that supply of waste facilities have a significant impact on the choice of alternative waste disposal options (Tadesse et al. 2008). Waste management facilities should be part of the initial infrastructure for any type of residential or commercial properties. In particular, basic requirements for the reduction and separation of waste at source should be enforced by local governments by, for example, insisting on the inclusion of separate containers for composting and recycling before building approval is granted (Ibrahim and Mohamed 2016). The probability of waste dumping in open areas

and roadsides increases if there is an inadequate supply of waste containers and if communal containers are a longer distance from residences (Tadesse et al. 2008). Conversely, as found in a study in Zhengzhou, China, waste separation increases in communities where waste-specific bins are readily accessible (Dai et al. 2017). Similarly, in a study conducted in Kuching, Sarawak, Malaysia on the perceived visual aesthetic quality of onsite waste storage facilities, researchers found that the provision of uniform mobile garbage bins seems to improve solid waste management systems (Chung et al. 2012).

Subjective social norms have a direct effect on recycling behaviour. These norms are shared beliefs indicating how people are supposed to act and they are enforced by the threat of sanctions or the promise of rewards. Subjective social norms are individuals' subjective beliefs about the norms of society or groups they belong to and are less internalised than moral or personal norms. Adherence to subjective social norms is determined by real or imagined social pressure (Thøgersen, 2009).

A study done in South Africa indicates that it is easier for households that already practice recycling to increase their recycling rate than for non-recycling households to initiate recycling (Strydom and Godfrey 2016).

Recycling activities that are integrated into a project at community level will encourage household participation in recycling. This, however, necessitates close consultation with and involvement of community members (Singhirunnusorn et al. 2012).

Another factor impacting on household recycling include whether households are situated in a rural or urban area. A comparison of two studies conducted in South Africa shows that although urban recycling increased after a period of five years, it still remained very low in 2015. The scope for recycling in smaller towns and rural areas is higher (Strydom and Godfrey 2016). Research on recycling habits of residents in high-rise dwellings in poor urban areas is scarce. Some of the barriers in this regard are lack of recycling bins, lack of storage space for recyclables at home, and lack of information about recycling schemes. One study indicated that recycling seems to take place less in these areas and concluded that the introduction of food waste collection in high-density properties in

deprived areas is not the most cost effective use of funds in the short term. Food waste does, however, comprise a relatively small proportion of waste in this context. Existing recycling schemes could nevertheless be improved with different communication and participative strategies (Rispo et al. 2015).

The type of materials recycled also differs and is reflected in recycling rates. Comparing two South African surveys conducted within five years, plastic household recycling increased to a large extent relative to recycling of glass and metal, while paper was the material with the smallest recycling increase rate (Strydom and Godfrey 2016).

Home composting plays an important role in reducing biowaste losses due to waste dumping and is recommended as a waste management option in agricultural regions, as proposed in a study on home composting in Romania. Apart from reducing biowaste, it can also replace chemical fertilisers, contribute to resource conservation, can be substituted for peat and can improve soil fertility and crop health (Mihai and Ingrao 2018). In a Tanzanian study waste reduction was observed and environmental sanitation improved (Mbuligwe et al. 2002). In a Romanian study, comparing different counties home composting in plastic bins produced better results than composting in open piles and was a preferred alternative to disposing of biowaste on conventional landfills. By using plastic bins the composting procedure can be subject to increased control and produces better compost quality (Mihai and Ingrao, 2018). Local governments can enhance this practice by providing special plastic bins and guidelines for obtaining quality compost. Furthermore, countries can collaborate to share composting experience. In terms of best practice, home composting practice can be enhanced in terms of economic and environmental benefits by combining it with source separate collection of recyclables and sanitary landfills, as is evident in the Balkan region. In rural Greek municipalities, good cooperation and proper information on source separation resulted in high recovery levels of biowaste. Cost reduction in developing countries can be achieved through the proper monitoring of qualitative parameters pertaining to method and ingredients. (Mihai and Ingrao 2018).

Composting nevertheless also poses some challenges. In a Tanzanian study some households were uncooperative, displayed negative attitudes, ignored waste separation

instructions and used the provided storage bags for storing other household items instead of waste. In addition households sometimes lacked appropriate places to store waste storage bags before collection and consequently domestic animals destroyed the bags and spread waste around the household sites. Poor infrastructure also posed some obstacles: bad road conditions resulted in collection delays and door-to-door collection was time consuming (Mbuligwe et al. 2002).

2.9.4 Waste collection systems, strategies and practices

Aguadze (2020), drawing on Kreith (1994) describes collection broadly as including both the assembling of waste and the hauling to the premises where the collection vehicle is unloaded. Collection of waste along with transportation and disposal are costly elements of waste management, particularly for low-income developing countries (Filho et al. 2016). Consequently, Filho et al. Stenmarck (2016) note that many cities fail to collect more than half of the municipal waste: in lower-income countries 41%, in upper-middle-income countries 85% and in some African countries as little as 10% is collected. Fortunately, in terms of waste management, the development of waste collection systems and the upgrading of waste management infrastructure rank as principal activities, while countries in transition have waste management infrastructure that needs upgrading. Upgrading is also required in developed countries to meet community demands as well as more stringent regulatory requirements and targets.

To promote minimisation of solid waste at source, effective collection systems should be in place and the collaboration of local authorities, the private sector and NGOs is necessary for improvement and policy development in this regard (Ibrahim and Mohamed 2016). Municipalities should take responsibility for the provision of simple but effective separation, storage and transportation tools to encourage best practices for inorganic waste (Ibrahim and Mohamed 2016). A study conducted in Indonesia by Sumbodo et al. (2021) also highlights the importance of customer satisfaction with waste service delivery in terms of collection. In this study factors that influence customer satisfaction with collection included staff attitude during waste collection, ability to inform customers about collection schedules, the reliability of the schedule, certainty of cost retribution and trustworthiness of staff, quality of waste transportation equipment, staff uniforms and availability of safety and health equipment for transporters.

A range of waste collection systems are recognized, including bring or drop-off systems and kerbside waste collection (Mwanza et al. 2018a). The system most widely used is the kerbside waste collection system. Moreover, it seems to be quite effective in recovery of PET plastic containers, according to a study conducted in the USA and even increased collection in comparison to bring systems. This can be attributed to the higher individual effort required for drop-off collection. However, drop-off proves more effective where kerbside collection is impractical. Buy-back centres hold an added financial incentive for residents that bring back recyclable or reusable waste to the facility (Mwanza et al. 2018a & b).

A study on waste collection systems in Cape Town indicates how historical legacies can be perpetuated by a cost recovery agenda of a neoliberal state. In particular, attention is drawn to a continued stratified treatment of citizens' rights to urban service delivery and the continuation of labour casualisation (Miraftab 2004).

2.9.5 Waste transfer and transport

Aguadze (2020), drawing on Kreith (1994), views transfer and transport as consisting of the transfer of waste from a smaller collection vehicle to larger transport and the subsequent transport of waste to the final disposal location. An interesting and holistic approach that is broader in scope than waste transport is advocated by Davies (2012). She coined the term "waste mobilities", which refers not only to how waste is transported, but also includes processes of waste relocation and rematerialisation and the impact in a wider sociocultural, economic and political context. She identifies four sub-themes, namely mapping flows, following things, illegal mobilities and immobilities. Firstly, research mapping flows highlights the interrelationship between trade, regulation and environmental justice, and traces the physical and political trajectories of end-of-life products. Secondly, the sub-theme of following things which subjects end-of-life objects to commodity chain analysis and investigates the constituencies of particular waste materials. Thirdly, research on illegal mobilities examines the geographies of illegal activities: how deficiencies in regulation enable trade and illicit trade of waste materials. A fourth research stream focuses on waste immobilities and the processes of decomposition and degeneration.

Waste transfer stations are functional when distances between the area of waste generation and treatment is long. However, this is still not standard practice in Latin America and the Caribbean. A few cities use transfer stations, but cover slightly more than 50% of the collection (Hettiarachchi et al. 2018).

2.9.6 Waste separation, processing and transformation of solid waste

According to Aguadze (2020), drawing on Tchobanoglous et al.(1977), processing and recovery incorporate technology, equipment and facilities that improve the efficiency of the other aspects of waste management as well as enable the recovery of usable material, conversion products and energy generated from solid waste. Recovery also encompasses separation to salvage valuable materials from mixed waste (Aguadze 2020). Material recovery facilities are essential for the processing and sustainable recovery of solid waste. Since composting is a highly effective measure to treat organic waste, particularly in agricultural developing countries, community composting should be encouraged (Ibrahim and Mohamed 2016).

Community-based decentralised composting projects can be successful in large cities in the developing world and they can be a good alternative instead of conventional solid waste management options, since they reduce the amount of waste to be transported and disposed of, as indicated by a study focusing on Bangladesh (Zurbrügg et al. 2005). It should be noted that the demand for compost by large bulk buyers was a significant contributing factor to the financial benefit of the project.

2.9.7 Waste disposal systems, strategies and practices

The availability of waste disposal facilities influences household waste disposal choices significantly. Therefore, it is imperative that the planning of city layout must enable access to every house from the road and (Boadi and Kuitunen 2003). In developing countries such as Ghana access to solid waste facilities is limited in low-income areas and should be upgraded (Boadi and Kuitunen 2003).

Provision of an adequate number of communal trash bins can prevent exposure to disease (Yoda et al. 2014). Communal container use depends on access and the

distance that users have to travel to dispose of waste. With an increase in distance and inadequate access, households may use alternative methods such as tractor-trailers or resort to illegal dumping (Tadesse et al. 2008).

Idowu et al. (2019) analysed the classification of landfilling systems in Sub-Saharan African (SSA) countries from 2000 to 2018. Landfilling systems were classified as characterised by uncontrolled dumping, as semi- or medium controlled or medium/high-engineered facilities or a high state-of-the-art facility. The authors concluded that 80% of the documented landfill sites assessed in SSA were classified as level 0 or 1, with no or limited control. In other words, the sites were characterised by uncontrolled burning as well as lacking lining systems, leachate collection systems and gas collection systems. The review recommended that identification and classification of all active dumpsites / landfills / dumpsites in SSA countries should be a high priority. Such a classification could enable corrective interventions to mitigate or reduce environmental threats and health consequences. The need for proper established and, where necessary, new landfills that comply with the necessary safety requirements and modern land-filling features is also clear from the literature reviewing specific African countries, e.g. Egypt (Ibrahim and Mohamed 2016).

The most commonly used means of waste disposal in Latin America and the Caribbean is uncontrolled disposal in open dumps. In Belize, Guatemala and Nicaragua uncontrolled open-air dumps are used. In addition, open-air burning and the disposal of municipal solid waste in bodies of water are problematic in especially Bolivia, Belize, Nicaragua, Honduras and Panama (Hettiarachchi et al. 2018). Landfills in the region are beset with operational and environmental problems (Hettiarachchi et al. 2018). Here the closure of the Bordo Poniente landfill in Mexico City, Mexico without the provision of alternatives serves as an example. Technical failures in landfills in Columbia led to danger and deaths from 1977 to 2005.

Studies have also shown that waste composition should guide waste disposal scenarios. However, waste composition is dynamic (Coban et al. 2018) and therefore selection of appropriate waste disposal scenarios can be complex. Selection requires tools that are fast and effective to create models of the most suitable and context specific solutions. Coban et al. (2018) investigated various disposal techniques utilised globally with the aim

of identifying methods suitable for the city of Istanbul in Turkey. The evaluation criteria for determining suitable waste disposal scenarios were based on three different multi-criteria decision-making methods, namely the technique for order preference by similarity to ideal solution (TOPSIS); preference ranking organization method for enrichment evaluations (PROMETHEE) I, and PROMETHEE II. This 2018 study covered several treatment technologies, took the interests of multiple stakeholders into account and considered both technical and social criteria. Viable disposal methods included recycling the recyclable materials of municipal solid waste at a material recovery facility and transporting a recyclable portion of the waste to the material recovery facility and after the operation at the facility the non-recyclable portion of the waste goes to the landfill site. The next preferable option would involve the same steps, but the non-recyclable portion of the waste is designated for incineration. The study confirms the prominence of recycling and landfill technologies for developing countries.

2.10 Waste management practices

2.10.1 Educational institutions

Educational institutions are viewed as instrumental in promoting sustainability in society (Iojă, et al. 2012). However, these institutions experience challenges in terms of integrated waste management. Iojă et al. (2012) assessed waste management methods in educational institutions in Bucharest, Romania, in order to determine the relation between the educational institution category and the quantity of generated waste, the impact of the number of persons on waste generation for each category, and the significance of waste management projects in awareness raising. The authors concluded that the type of educational institution is of greater significance in determining waste volumes than the number of students. In this regard, pre-schools and high schools produced the most waste. Factors impacting the waste volumes in these institutions include long school programmes necessitating provision of meals and a dormitory function. The waste quantities showed similarities to those in the European Union, but were higher than the volumes generated in Asian and African countries. At the time of the study most educational institutions did not have a waste quantity monitoring system. The authors recommended selective waste collection and educational projects as essential to promoting sustainability. Waste management plans also need to be aligned with the characteristics and infrastructure of educational institutions.

A study conducted at four higher education institutions in Western Kentucky (Ebrahimi and North 2017) found that there is a direct correlation between money invested and personnel investment in waste management programmes and good performance in waste diversion. The authors posit that even low-cost initiatives can contribute to reduced waste production. As a baseline, waste bins and signage should be installed. Another common denominator at the universities was the development of a waste plan with a timeline to become zero-waste campuses. Awareness-raising and behavioural change programmes should be provided, as well as addressing infrastructural needs. As a starting point, universities could sign a commitment to engage in environmental stewardship and ensure accountability. Stewardship-centred policies can then be based on the commitment. Regular evaluation of the programmes would allow for changes to enable implementation. In addition, the campus must be targeted in its entirety and waste management decisions should be based on survey data from the community. Identification and participation of all stakeholders would be beneficial and comprehensive waste audits should capture the current status of the university's waste streams and ensure appropriate allocation of waste reduction resources. Where financial resources are limited, students can be involved in the waste audit. The implementation of an EPP could ensure the purchase of healthy and environmentally friendly products. Sustainable procurement policies are desirable. On the management front, management structures of surplus and recycling programmes should be separate, but complementary operations must be possible (Ebrahimi and North 2017).

A study at Olabisi Onabanjo University, Ago-Iwoye, in the south-western part of Nigeria, (Ifegbesan et al. 2017) led to some similar recommendations in terms of environmental policy formulation and solid waste audits. The authors found that extensive intervention is required for campus sustainability. Paper and pen products contribute widely to solid waste generated on campus and can be reduced by intra- and internet facilities for information circulation and results processing. In addition, indiscriminate posting of information on posters on walls and doors should be discouraged. Recycling of used papers should also be encouraged and refillable cups should be promoted instead of single-use beverage and water containers. This study implies that student-focused sustainability education or campus-based sustainability education should be

implemented. Education is a primary factor for meaningful engagement in environmental behaviours and sustainable living. The core values of environmental education should be integrated into their programme curricula and non-formal activities such as students' associations and orientation weeks. Environmental policy for universities should be formulated and implemented and it can highlight annual solid waste audits.

Certain attributes can foster waste separation in university communities, as found in a study conducted at a university in Malaysia, namely accessibility of the recycle bin, incentives, reminders and relevant information. These attributes can assist university management to make informed decisions about the allocation of limited resources to encourage waste separation behaviour in university communities (Sheau-Ting et al. 2016).

2.10.2 Awareness and information campaigns

In a review of solid waste management in Africa, Bello et al. (2016) argue that perceptions of and orientation around waste need to be addressed. Waste should not just be perceived as harmful, but as an opportunity to generate income. This is especially the case in countries where the development of modern and efficient waste management planning is still in its infancy. With regard to Kazakhstan, Inglezakis et al. (2018) urge that awareness and education are very important to promote separation at source, which is dependent on the willingness of citizens to collaborate with waste management operators. Education and awareness are intermediary steps to prepare citizens to participate in decision making and to garner public support for the implementation of waste management policy (Inglezakis et al. 2018).

Awareness mechanisms such as interactive programmes, television and radio broadcasts, educational tours and exhibitions can be used to disseminate information and promote citizen participation (Ibrahim and Mohamed 2016). However, different groups prefer different information distribution channels. In a study conducted in Oyo State, Nigeria, policy implementers expressed a preference for personal contact as a channel for the distribution of environmental information. Policy formulators preferred posters, radio/TV talks and professional meetings (Akintola et al. 2009).

Akintola et al. (2009) identified barriers to information dissemination. These included lack of access to information sources, lack of standards for acquisition of information and lack of funds to publish information materials.

Mwanza et al. (2018b) cite studies by Oskamp et al. (1991), Tonglet et al. (2004), Chenayah et al. (2007), Nixon and Saphores (2009), Singhirunnusorn et al. (2012) and Xevgenos et al. (2015) which confirm that awareness and knowledge about the implementation of waste management systems and recycling behaviour can influence corresponding behaviour. This finding is also confirmed in a study conducted in Aprilia, Latium, Italy where an information campaign seemed to result in an increase in awareness and improved waste management, and communication and education were identified as key factors (Del Cimmuto et al. 2014). Health education in the form of lectures and focus group discussions also improved knowledge about the problems and diseases associated with accumulated solid waste in a study in Al Ghobeiry, Beirut (Karout and Altuwaijri 2012). In this study educational brochures, posters and books were used in the various educational sessions and activities employed.

2.10.3 Technological approaches

A “green engineered” smart recycling bin, designed with energy usage and modularity in mind, was used to test recycling behaviour. It was augmented with sensors to count recycled items and to give eco-feedback. It included a numerical LED screen and lights and a short audio file. Mozo-Reyes et al. (2016) note that other smart bins such as the SmartBin products and the Dream Machine had previously been on the market, but that these products were not widely available and did not provide user feedback at market price. The WeRecycle bin yielded better results than a non-technological engagement intervention. Effectiveness was enhanced by interactivity, immediate feedback and subtlety of colour and pictorial realism. The bin attracted users and engaged them, seemed better cared for, was less contaminated and could increase the number of items recycled at events. Psychologically, electronically delivered stimuli increase recycling by responding to group behaviour and change. Positive attitudes towards recycling were evident when users received immediate feedback and the authors suggest that the feedback allowed recycling to be perceived as enjoyable and worthy of time invested, and encouraged curiosity. They recommend that the bin location should be changed so that

the intervention remains new and exciting (Mozo-Reyes et al. 2016).

2.10.4 Resistance campaigns

Some studies on the waste crisis in Lebanon investigated public participation and mobilisation flowing from a lack of waste management. Khalil (2017) explores the participation rights of children (see the UN Convention on the Rights of the Child Articles 12 and 17) in the You Stink protest movement during a waste collection crisis and the violation of their rights to safety, protection, participation and freedom of expression. His analysis shows how children were used by both their parents and the media as “poster children” of the resistance movement in the absence of regulations regarding their involvement in media. Furthermore, the campaign attracted young people and children to volunteer and participate in sit-ins, social media, flash mobs and the production of material for live broadcasts and how their media development and distribution gave them voice and agency. Apart from children and young people, the movement also attracted the support of artists and media reporters.

Participation is promoted through digital technologies, practices and cultures, and takes place both on- and offline. Young people are positioned in “varied geographies of relational connectivity and transitivity” (Amin in Khalil 2017: 707) and consequently exhibit hybrid identities and political allegiances, but social media enhance their connection outside polarised politics. However, in the Lebanon case study different political perspectives did eventually lead to fracturing of the movement when one group demanded a new president. The media resistance campaign is an example of how participants can voice opposition and criticism to government’s mismanagement of the waste crisis and the implied indifference to harm for future generations through new modes of participation in public life. These new modes differ from legacy media (radio, television and print media) in the sense that the latter focus on the formal participation of young people and children, demonstrate parental and media control and curation, and ignore power dynamics and conflicting interests in their representation of young people and children (Khalil 2017).

Kraidy also notes that the You Stink movement aimed at establishing a non-sectarian citizenship where citizens resisted “an entrenched, corrupt, and venal elite” (2016: 20),

including all politicians and “ostensible neutralisation and co-optation attempts by various players within the sectarian political system” (Kraidy 2016: 20). The impact of sustained political leadership failures are also evident. Kraidy also characterises the You Stink movement as one of the NIMBY social movements, which are generally prone to goal expansion. In this case these goals included radical reformation claims like the “resignation of the Minister of the Environment, a sustainable waste management strategy and plan, parliamentary elections and tackling corruption in the political class, and later, sanctioning police officers involved in brutality against demonstrators” (Kraidy 2016: 22-23). According to Kraidy, the movement also took ownership of the garbage crisis by “diagnosing and proposing solutions to the garbage crisis in Lebanese public discourse, in the process exposing the depth and breadth of government corruption and incompetence” (2016: 23). Kraidy notes that ownership involves feeling morally obligated, developing a frame of environmental expertise and being involved in the assessment of and search for solutions to problems, being cognitively independent from official discourse and pinpointing the contribution of authorities who are ineffective and untrustworthy to the problem. Furthermore, other markers of ownership included coordination or convergent agendas. As a consequence, the garbage crisis was “opened [...] up to public scrutiny, deliberation, and contention” (Kraidy 2016: 23) that enabled parties to envision a better future. In terms of mobilising the public, Kraidy (2016) identifies social class as an obstacle.

Another dimension of the garbage crisis emerged in reaction to the suppression of demonstrations when some You Stink activists attempted hunger strikes and self-immolations in what Kraidy terms “embodied protest” (Kraidy 2016: 25) .

2.10.5 Educational interventions

Proper waste management education of the public is essential to improve perceptions and practices and address related municipal challenges like improper waste disposal (Yoada et al. 2014). A study in Hong Kong also confirmed that strong and rigorous educational programmes are necessary to improve knowledge and attitudes towards recycling, waste charging, landfill extension and development of new incinerators (Yeung and Chung 2018). Health education in the form of lectures and focus group discussions on the problems and diseases associated with accumulated solid waste was used as an

educational intervention in a study in Al Ghobeiry, Beirut (Karout and Altuwaijri 2012). In this study educational brochures, posters and books were used in the educational sessions and various educational activities employed. Importantly, training was also provided to the educators and a selection process was undertaken to choose trainers (Karout and Altuwaijri 2012).

The involvement of representative teachers in the design and pretesting of teaching material was important in a case study on the systematic development of an awareness and communication multimedia package in solid waste management for Egyptian technical secondary schools (Kandil et al. 2004). Both the national government and NGOs can be involved in the provision of waste management training and related resource centres across the country (Ibrahim and Mohamed 2016). Training could probably be provided to increase local capacity in data collection and analysis in solid waste management, since this has been pointed out as an issue in developing countries such as Ghana (Boadi and Kuitunen 2003).

Content in educational packages for Egyptian technical secondary schools included environmental concepts (basic definitions, environmental spheres, identification of environmental systems), environmental issues (local, national and international), solid waste management (sources of waste, lifecycle analysis, recycling, technological aspects, environmental auditing, legislation for solid waste management and case studies (successful cases of solid waste management) (Kandil et al. 2004). In a study conducted in Al Ghobeiry, Beirut, randomly selected inhabitants (including housewives and unmarried single male workers) who came from different Lebanese ethnic and religious groups that were characterised by low income were subjected to a health education programme. The content of the programme included knowledge about types of, composition and elements of municipal solid waste, the disadvantages and diseases following from bad municipal solid waste management, gathering, separation, prevention, reuse and recycling of municipal solid waste as well as information about the role of community-based initiatives play in municipal solid waste and hazardous waste (Karout and Altuwaijri 2012).

2.10.6 Green practices and hotel practices

Ghadban et al. (2017) studied the impact of the trash crisis in Lebanon on the Lebanese tourism industry. In particular, they focused on how hotels managed their waste to mitigate the impact of the crisis and investigated the visitors' perceptions of solid waste management. Large hotels had more effective waste management systems in place than smaller hotels. Smaller hotels identified high management costs, limited financial resources and management decisions as challenges to implementation, while large hotels ascribed implementation challenges related to culture, limited number of companies and NGOs dealing with waste management, and lack of staff awareness. Ghadban et al. (2017) suggest that stakeholder configuration mapping and the association of strategic actions will help hotels to pinpoint the participation of stakeholders, clarify the involvement of stakeholders in sustainable waste management plans, and identify stakeholders with the potential of adding additional value in the form of, for example, financial aid. Raising guest awareness and encouraging waste reduction as well as integrating risk management into business planning may provide additional avenues of addressing waste management implementation challenges. The study also indicated that the implementation of solid waste strategies was not a primary factor in the selection of hotels by guests.

Radwan et al. (2012) studied solid waste management in small Welsh green and non-green hotels. Non-green and green hotels differ. The latter exhibited commitment to environmental responsibility in terms of developing an environmental policy, engaging in an environmental audit and drawing up an improvement plan. Hoteliers were positive about sustainable options, with the exception of composting. The non-green hotels were not in favour of alternatives to landfill, except for recycling. On the basis of this research Radwan et al. (2012) developed a best practice model for both local and central government that would promote enhanced solid waste management practices in small hotels. The public sector can use a variety of strategies to promote effective solid waste management in small hotels, namely provision of tools and facilities, raising awareness by training, increasing economic benefit, enhancing social motivation and marketing innovation, increasing legislative pressure and network building between small hotels. Furthermore, the national waste strategy can be revised to reduce solid waste management at source and to encourage accessible green product production. The seven steps mapped out for better solid waste management include hotel commitment to

environmental responsibility, engaging in a waste audit, working with contracted waste carriers, implementing solid waste programmes based on the waste hierarchy, overcoming intrinsic barriers to effective solid waste management such as lack of space, time and cost-related issues, encouraging staff participation in the solid waste management programme and involving customers in the solid waste management programme.

A study by Yusof and Jamaludin (2015) investigated green practices of small island chalet operators on the Kapas and Tioman islands in East Peninsular Malaysia. Although some similarities were observed in terms of, for example, materials and resources and sewage management, solid waste management differed between the operators. Kapas Island was cleaner because of the daily cleaning and waste collection as well as the presence of many waste bins at the beach. Tioman Island, located at a distance of a two-hour ferry ride from the mainland, was serviced by municipal workers only every two to three days. In addition, the waste vessel had a small capacity and only collected domestic waste and not construction waste. Consequently, construction waste and bulky waste, for example, boats, batteries, oil drums and fridges, were dumped on the beach or at the chalet area. The density of tourist establishments (chalets and village houses) generated a large amount of waste daily. Recycling was also not provided at the beach, while conversely, the operators on Kapas Island did apply the principles of 'recycle, reduce and rethink'. The correlation between green practices and operators' knowledge and educational background was strong (Yusof and Jamaludin 2015).

2.10.7 Stakeholder participation

Government involvement could be beneficial where local capacity is lacking. For instance, Boadi and Kuitunen (2003) have noted that data collection and analysis in solid waste management must be monitored. Here government involvement in periodic sourcing of solid waste data can provide the basis for the selection of appropriate technology (Boadi and Kuitunen 2003). Government should take responsibility for promoting public participation and in this regard initiate awareness programmes (Ibrahim and Mohamed 2016). Since local recycling businesses have a lot of experience to share, they should be involved in the waste management planning process and outcomes (Ibrahim and Mohamed 2016). Even low-income communities could be encouraged to participate in

recycling by providing proper training. This could generate extra income and improve the public perception of waste management practices (Ibrahim and Mohamed 2016). In a study of the role of urban residents in Ghana, Cobbinah et al. (2017) found that the government did not involve the public, since municipal solid waste management was considered the responsibility of the government. This lack of involvement, despite initial expressions of willingness to actively participate, leads to gradual apathy.

The involvement of communities can be an efficient tool to change communal waste management regarding source segregation, recovery of recyclable materials and storage prior to collection. Singhirunnusorn et al. (2012) note that community projects reduce littering, improve community solid waste management, address health problems and promote a cleaner living environment. A community project has the potential to create jobs, provide supplementary income within the community and to reduce municipal costs of solid waste handling and disposal. Moreover, it has the added benefit of creating a sense of belonging in terms of which citizens solve common environmental problems together. Furthermore, where projects are initiated locally, community members may experience a sense of ownership and engagement. One example would be solid waste recycling banks, for instance, such as those operated in Thailand (Singhirunnusorn et al. 2012). Boadi and Kuitunen (2003) also state that the involvement of communities in waste management decisions may increase community agency in waste management in low-income areas and encourage mobilising efforts and the use of local resources. Kirkman and Voulvoulis (2017) add that public involvement early in the decision-making process by, for instance, informed local debate can support the development of high-quality national infrastructure. In addition, it allows for a better platform to present arguments for building infrastructure and can decrease opposition to infrastructure projects. To gain support, a consistent message and a neutral credible voice outlining independent evidence about challenges and possible solutions are required. The goal is to move away from dictating dogmatic solutions and to encourage not just public acceptance but understanding of infrastructure, the nature of infrastructure investments and development, the costs and benefits, and the technological aspects. The level of public participation rises from informing them, to consulting, to involvement through dialogue and interaction to collaboration, where the public partners with or works jointly with other waste management stakeholders (Kirkman and Voulvoulis 2017). Berthomé and Thomas

(2017) assessed the performance of participatory schemes in environmental planning. The performance or productivity of stakeholder dialogue depends on more than just technical expertise or community experts. Perceptions and bargaining power play a role. The discrepancy between initial objectives of various agents also influences stakeholder dialogue. Another factor that has an impact on successful negotiation is the willingness to reach an agreement.

An early study by Kang (1999) on factors influencing willingness to participate in recycling, conducted in Los Angeles, and focussing on Korean-Americans, found that a community's volunteer activities, recycling by friends and neighbours, type of dwelling, Korean television, radio and newspapers, English television, radio and newspapers, and income were relevant in promoting recycling. Mwanza et al. (2018b) identified levers that influence households' participation in waste recovery programmes, namely social demographic factors, legislation and regulations, awareness and knowledge of recycling, waste collection systems and material recovery facilities. Elven factors promoting participation in recycling behaviours were identified by Tiew et al. (2019). These included recycling behaviours, attitude, subjective norms, easy access to recycling facilities, home recycling practices, recycling cost, willingness to adopt recycling practices, environmental impacts, the role of religion, rewards and incentives, and charity. The authors recommend that policy makers pay attention to strategies engaging community residents to change their attitudes, address environmental impacts and adopt recycling behaviour. The potential of rewards and incentives should also be considered in planning, as well as age, occupations and lifestyle types (Tiew et al. 2019). A South African study found the factors of monthly income, being married, race, paying and willingness to pay for waste disposal, the existence of waste recycling programmes and facilities were correlated with recycling (Oyekale 2017). In a study conducted in Guilin, China, Ma et al. (2018) identified measures in municipal solid waste source-separated collection programmes that promote public participation. These include improvement of convenience, improvement of facilities, introduction of incentives, and enhanced enforcement of legislation and regulations.

Participation in household composting was influenced by age older than 45, possession of a garden, engagement in waste segregation and peri-urban residence (Nsimbe et al.

2018). Nsimbe et al. (2018) investigated composting in Uganda and found the incidence of composting to be low.

Attracting investor participation from both local and foreign investors must be facilitated by policy measures like guaranteed safety of investments, the creation of free trade zones and the removal of bureaucratic bottlenecks. Local investment can be encouraged by soft loans to small businesses for expansion of activities. In addition, local entrepreneurs can be encouraged to form cooperatives to mobilise funds that can be used for investment (Boadi and Kuitunen 2003). International investment in terms of knowledge and technical know-how could also be beneficial. Bello et al. (2016) recommend drawing up bilateral agreements with international partners to promote environmentally sound waste management streams and emphasise the importance of meeting international agreements on waste management and provision of assistance to African countries.

Non-governmental organisations (NGOs) and community-based organisations (CBOs) play an important role, comparable to that of the private sector, in giving access to urban sanitation and solid waste services to the poor in informal settlements, for example, in Kampala, Uganda (Tukahirwa et al. 2011). Social proximity explains access of the poor to the services provided by the NGOs and CBOs. Cooperation between households and these organisations and trust further enhances access. Therefore, Tukahirwa et al. (2011) suggest ensuring that social networks function and building trust in NGOs and CBOs and their services. In a later study conducted in the capitals of Kenya, Tanzania and Uganda, Tukahirwa et al. (2013) highlight the differences between these civil society organisations in terms of involvement in sanitation and solid waste provision, socio-economic characteristics of service recipients and non-recipients and in the ways these systems are appreciated. These NGOs and CBOs have their role besides other institutional arrangements. Their growth is stimulated by poor service provision and privatisation. Institutional collaboration with private solid waste management institutions vary. An example of strong collaboration would be Dar es Salaam, where solid waste services are clearly allocated among the various institutions (Tukahirwa et al. 2013).

2.10.8 Stakeholder synergy

Active private sector involvement in waste management in developing countries in Africa

should be encouraged (Bello et al. 2016; compare Mihai and Ingraio 2018). Limitations on government finances and resources also necessitate private sector partnerships (Ibrahim and Mohamed 2016). However, studies in developing countries such as Egypt and Ghana reveal that private sector involvement in service delivery is limited and does not always result in improved solid waste management (Boadi and Kuitunen 2003); Ibrahim and Mohamed 2016). Challenges include inadequate financial and human resources (Boadi and Kuitunen 2003). Different measures have been suggested to address these obstacles. Boadi and Kuitunen (2003), drawing on Bartone and Leitman (1994), recommended the provision of soft loans for equipment acquisition and the appointment of qualified staff and the promotion of private sector involvement in service delivery through competitive concessions for waste management. Private sector partnerships must take place in a proper and just investment environment and policy measures should enable authorities to monitor and assess private sector partnerships (Ibrahim and Mohamed 2016). A study on domestic waste disposal practice and perceptions of private sector waste management in urban Accra suggested that the use of private contractors could also address health-related risks such as the prevention of diseases (Yoda et al. 2014). In addition, private sector involvement will generate employment opportunities (Bello et al. 2016). Keyter (2010) investigated perceptions of stakeholders involved in a public-private partnership arrangement to provide solid waste management services in Windhoek, Namibia. Against the background of the changing role of the public sector in terms of becoming a facilitator for “private-led economic development and growth” (Keyter 2010: 19) and the increasing demands on governments for service delivery, public-private partnerships address public needs through joint efforts. PPPs can at least have partial ownership and management of services and be politically accountable to the relevant constituents. The study indicated that community involvement in decision making should be facilitated to allow for feedback to ward contractors and improvement of relationships between partners. Furthermore, community participants need to be well informed. Public-private partnership principles of transparency and accountability need to be strengthened and the use of ethical business practices encouraged.

The cooperation between consumers and producers has also been studied. Factors that inhibit cooperation include asymmetric information, vested interests, the “tragedy of the commons” (Wiesmeth et al. 2018, with reference to Wiesmeth and Häckl 2011).

2.10.9 Governance approaches, decision support and selection of alternatives

Governance can be defined as a process of collective social compromise by various social actors such as central/local governments, the market or different community members (Hettiarachchi et al. 2018). Within a more classical framework, forms of governance are differentiated by the extent of government control. Hettiarachchi et al. (2018) differentiate between bureaucratic governance, market governance and network governance.

Particularly in developing countries, good governance is essential to improve solid waste services. These include accountability, transparency (Hettiarachchi et al. 2018; Filho et al. 2016), the rule of law, legitimacy and increased capacity (Filho et al. 2016), participation and predictability (Hettiarachchi et al. 2018). Moreover, municipal solid waste management serves as an indicator of the ability of municipalities to handle management structures, contracting procedures, labour practices, accounting, cost recovery, corruption, poverty and equity (Hettiarachchi et al. 2018). Conversely, when proper institutional, financial and participative strategies are not in place, governance can be characterised as unstable or immature. In Latin America and the Caribbean, for example, a proper legislative framework, integrated municipal solid waste management systems, funding efficiency and public-private partnerships are deficient (Hettiarachchi et al. 2018). In Kampala, Uganda, the emergence of a new municipal body, the Kampala Capital City Authority (KCCA), after protests questioning the legitimacy of the national government to clean up public spaces, also illustrates how waste management governance mirrors general political governance issues (Doherty 2019).

Bureaucratic governance centres on following the rules of a hierarchic authority of, for example, the government. Common social goals are achieved through the organising principles of authorities and rules. If the authority enforces task performance and raises funds effectively, bureaucratic governance can be effective. Conversely, when the authority is corrupt, governance will be ineffective. In Latin America and the Caribbean enforcement of municipal solid waste policies is ineffective due to weak government power. Legislation is weak, the responsibility for municipal solid waste management is allocated to local municipalities with a lack of resources, lack of political and legal will and

lack of long-term commitment and is plagued by corruption. Furthermore, roles and responsibilities are not clearly defined and allocated which results in overlap (Hettiarachchi et al. 2018).

Examples from best practice that may enhance bureaucratic governance include collecting waste management fees with those for other public services, since this results in the highest return compared with property tax, which is the current dominant method of waste service billing in Latin America and the Caribbean (Hettiarachchi et al. 2018). Another way of improving bureaucratic governance is to establish a public solid waste service company with administrative and financial autonomy and to bill through the company, such as the Municipal Public Urban Cleaning Company in Cuenca, Ecuador. This company is financially efficient, environmentally friendly and compliant with local legislation. Its fee structure includes criteria for a collection fee, a public cleaning fee and collecting methods. A municipal ordinance regulates the fee structure of the company. It is one of the few financially self-sustaining solid waste providers in Latin America and the Caribbean, and recovers its investment and operational costs (Hettiarachchi et al. 2018).

Market governance is dependent on market power. In theory it guarantees efficiency and maximises the interests of society because everyone exchanges in pursuit of their own interests. Incentives, prices, contracts and remuneration which encourages performance are important aspects of market governance. The achievement of goals with minimum costs and the generation of revenues are attractive aspects of market governance. However, if the market fails or is interrupted, this type of governance is not efficient or effective. In Latin America and the Caribbean, however, municipal solid waste is not perceived as a resource and this perception is not conducive to effective market governance and hence markets related to waste management are undeveloped and low interest from the private sector inhibits business growth in waste-related business and impacts on municipalities in need of the assistance of private companies to collect and treat waste (Hettiarachchi et al. 2018).

Initiatives that can improve best practice in market governance include providing incentives to the private sector by creating efficient markets through service contract transparency, the award of concessions to the best bidder, avoiding the use of public

resources for private use, resisting bribery and favouritism, and the implementation of monitoring and supervision systems (Hettiarachchi et al. 2018). Proper monitoring of solid waste management services is necessary for effective delivery (Murad and Siwar 2004). A private sector organisation type that enhances market governance is the microenterprise. They have fewer employees, keep costs low, use simple technologies, encourage community participation and generate community employment. Apart from increasing private sector involvement, economic incentives like the Clean Development Mechanism as implemented in Brazil and Mexico can participate in solid waste management from bigger enterprises with technology and capital (Hettiarachchi et al. 2018).

Network governance encourages public and private participation. Norms, values, customs and trust are important aspects of network governance. Within this type of governance people who are directly involved participate in the problem-solving process through democratic decision-making. Although it has received a lot of attention in the sustainable development and public-private partnership context, network governance can be slow in delivering results. Waste picker-related issues (small scale operations, labour intensity, low payment, low technology, poor hygiene and safety) challenge network governance but may also provide opportunities for network governance.. Waste pickers collect and recover between 10 and 50% of waste in Latin America and the Caribbean. And 0.5–3.8 million people are estimated to be involved in waste picking. Organised waste pickers participate and negotiate within a system of network governance and have the potential to strengthen network governance where they are a predominant group of actors in a region. Inclusion of waste pickers in public strategy and policy development processes has been shown to be easier if they are organised in unions or cooperatives – such as in Managua, Nicaragua, where the municipality and NGOs involved the waste pickers in the provision of waste collection services in informal settlements and supported the waste pickers to create a cooperative. In Villa El Salvador, Peru, eight recyclers' associations were designated to collect in their own designated pick-up areas. The promotion of the collection service by customers or service users were incentivised by the provision of a monthly discount of 20% on collection cost. In Columbia the formation of waste picker cooperative movements have been supported by a non-governmental organisation, the Fundación Social. As Hettiarachchi et al. (2018) note, recognising and

integrating informal waste reclaimers not only contribute to grassroots development in solid waste management but also promote poverty alleviation and environmental protection. Another complementary strategy that enhances network governance is the promotion of public involvement through, for example, programmes like the one in Curitiba, Brazil, where waste is purchased by the municipality in exchange for transportation vouchers and later food items, or the garbage exchange programme in Cuauhtémoc, Mexico, where six bags of garbage were exchanged for one bag of basic food items informed by suggestions from the community about food type. Programmes raising awareness and providing training on governance informs the public about the rights and obligations of all stakeholders. Hettiarachchi et al. (2018) recommend the incorporation of municipal solid waste management in formal education curricula, educational campaigns emphasising human values and public participation in planning and implementation of solid waste management, and effective communication to overcome indifference and unsustainable practices. The public needs to understand the requirements of municipal solid waste management and to actively participate through all project stages. Programmes aimed at the promotion of environmental awareness of children in terms of waste reduction, proper handling of municipal solid waste and environmental concerns have been used in Brazil, Chile, Colombia, the Dominican Republic, Ecuador, Mexico, Paraguay and Peru, while the ones in Columbia and Brazil persisted and have been successful – for example, the “La Molina Ecologica” grassroots-level programme involving awareness campaigns enabling direct dialogue with families on municipal solid waste issues.

Kubanza et al. (2017) propose, in the context of Kinshasa, that participatory governance involving municipal authorities, private companies and NGOs/CBOs/CSOs/other community and social organisations in collaborative ways will facilitate an appropriate waste management system and enhance environmental justice Kinshasa, DRC). This is a rights-based approach that allows community participation and empowerment of the poor and disadvantaged (Kubanza and Simatele 2016). Sentime (2014) also notes that South African legislation in the form of the Municipal Systems Act 32 of 2000 compels local governments to actively engage with communities in municipal issues. Moreover, communities are an integral part of the process and specifically involved in planning.

Government authorities need to involve community members in decision-making regarding natural resource use and environmental questions. Toteng et al. (2005) found that community participation was hampered by lack of involvement by the state in a survey conducted in Gaborone and Maun, Botswana. They recommended that an urban ecosystem management framework should be used in urban development to pinpoint ecological issues and to emphasise stakeholder involvement in decision-making. This model foregrounds human-environment interdependence, how society's organisation and structure affect natural systems and quality of life, in particular the impact of human systems on the natural system. Principles foundational to the urban development model include carrying capacity, which influences the planning and management system as well as being affected by understanding people's perceptions and other factors impacting behavioural change. Another principle is feedback. Positive feedback incentivizes activities that increase ecosystem performance and is typical of young ecosystems, while negative feedback has a penalising function in response to activities that exacerbate ecosystem dysfunction. Negative feedback is more prevalent in mature ecosystems which have almost reached maximum carrying capacity. The authors, with reference to Brugman (1992), note that municipal managers should implement feedback in by-law enforcement, e.g. building development control, financial management and other subsystems. Feedback can direct and regulate pollution as a factor impacting on carrying capacity. A third principle is integration – disintegration can affect relationships between human settlements and ecosystems, and impact the effectiveness of mechanisms that enable harmonious living of human communities in natural systems.

Decision-making about waste campaigns in Romania by national, regional or local authorities is not marked by community involvement. As Tartiu (2011) indicates, these campaigns are often organised without investigating community perceptions of waste and problems related to waste and without studying the motivation for environmentally friendly behaviour.

2.10.10

Policy and legislative approaches

2.10.10.1 Introduction

Bello et al. (2016) note the importance of enforcing laws and policies on waste

management in Africa. In this regard, Gilbert and Fumba (2011), in an earlier study on waste management in Cape Town, thought that local authorities need more stringent legislation to bolster their initiatives. Compliance in terms of waste management plans in accordance with municipal integrated waste management plans and enforcement of waste management by-laws is imperative (Gilbert and Fumba 2011). In terms of directions for policy and legislative development, a move towards the decoupling of environmental pressures and economic growth has also become recognised as necessary to achieve sustainability. In this regard, a study reporting on a workshop in Kyoto, Japan drawing on research from several countries foresees that 3R and resource management policies and waste prevention will play an important role (Sakai et al. 2017).

Jones et al. (2010) provide a brief typology of policy instruments for solid waste management. They distinguish between command and control instruments, market-based instruments and voluntary instruments. The first category finds its basis in the level of control in a community and environmental awareness. Command and control instruments include waste regulations pertaining to the public and industry. Non-compliance is met with specific penalties. However, these instruments may not be effective because they do not foster compliance and enhance environmental quality.

The second category, namely market-based instruments, are perceived as more effective since they are linked to incentives. They include instruments of negative incentives (e.g. revenue taxes or “pay as you throw” policies), instruments of positive incentives (funding opportunities or tax reduction for waste minimisation or recycling participation) and mixed incentive instruments (e.g. deposit-refund systems).

The final category, voluntary based instruments, does not provide incentives (e.g. voluntary participation in recycling) and its effectiveness is debated.

Yusop and Othman (2019) also provide a classification of policy instruments, but they caution that since public policies can be described as interventions by the government to alter the governance or social behaviour to achieve policy objectives, they are very much context-specific. Different instruments may therefore be selected to address similar problems. Yusop and Othman construct a grid of policy instruments taxonomies citing

examples from literature. The grid is based on the work of Bemelmans-Videc, Rist and Vedung (2010), Elmore (1987), Howlett (1991), Linder and Peters (1989) and Schneider and Ingram (1990). The taxonomy strings are (1) distributive, redistributive, regulatory and constituent; (2) nodality, authority, treasure and organisation; (3) information, economic means and regulation; (4) mandate, inducement, capacity-building to system-changing; (5) continuum and (6) authority, incentives, capacity building, symbolic, hortatory and learning. Yusop and Orthman identify examples of the implementation of authority, inducement, capacity-building and system-changing as policy tools in the Malaysian context to stimulate recycling intention.

An important aspect of policy and legislation as measures to address waste management challenges is their coordination. As He et al. (2018) note, strong coordination can reduce redundancy, expand innovation capacity, encourage superior responses to a complex municipal solid waste problem, and strengthen the legitimacy of outcomes. Conversely, poor policy-making coordination hampers accountability, increases response time and costs, negatively impacts on public respect for policies and leads to internal conflict between governments, sectors and service providers.

Policy implementation practice can be analysed in terms of its aspects of reframing, anchoring and muddling through as demonstrated in a study on the translation of policies into informal settlements' critical services in Kisumu City in Kenya (Gutberlet et al. 2017). Reframing gives focused meaning to policies and facilitates policy implementation processes. However, inclusion and exclusion in terms of framing impact on meanings and interests, and affect the actors, communities and parts of cities and territories that are included, excluded or represented. Anchoring of policies into local practice, institutional arrangements, budgets and decision making and enrolment or inclusion of policy actors can overcome resistance and encourage policy implementation. Conversely, insufficiently anchored policies may fade away. Importantly, policies need to exist for a certain time in a community of practice and transform into taken-for-granted solutions.

2.10.10.2 Command and control instruments

In terms of the first category, a holistic approach to waste management legislation and policy necessitates that the total value chain of waste minimisation be taken into

consideration (Gilbert and Fuma 2011).

The EU has an overarching legislative framework for waste management, based on the waste hierarchy and the promotion of integrated waste management. Although all member states are subject to the same targets, they can develop their own waste governance approaches (Filho et al. 2016). A specific example can be found in the management of solid port wastes, which is part of an overall environmental management system and is effective (Jaccoud and Magrini 2014).

Command and control instruments have been recommended to increase participation of households in waste separation at source (Mwanza et al. 2018b).

Developing countries showcase both good and less effective practices in terms of legislation and policy. Taking the Brazilian legislative and policy framework as an example from the Latin American region, the enactment of the national policy for solid waste (NPSW) was followed only after two decades of debate in the Brazilian Congress. Although it was preceded by extensive discussions among the government, private institutions, non-governmental organisations and civil society which is not necessarily negative, the prolonged process can also be attributed to the numerous commissions created for the purpose and parliamentary neglect of environmental issues (Filho et al. 2016). Questionable priorities and over-extended consultation can therefore delay significant legislative change. The overarching nature of the NPSW is a positive feature. In terms of content it contains principles, objectives, instruments and guidelines for integrated solid waste management also pertaining to hazardous waste, generator responsibility, public power and economic instruments. In terms of scope it is applicable to national, state, regional and municipal solid waste plans and covers integrated waste management, shared responsibilities, reverse logistics and social inclusion of collectors) is a positive feature. In addition, the NPSW can be applied with other Brazilian environmental legislation and policies; this capacity for integration is constructive.

Relaxation of command and control instruments can also be considered to address waste management in reuse exchange settings such as car boot sales. Within the context of UK waste policy relating to second-hand trading outlets, Gregson et al. (2013) recommend

the stimulation of trade to increase reuse by allowing more frequent trade at particular sites through the relaxation of planning regulations and by making the circulation of surplus goods easier.

2.10.10.3 Market-based Instruments

Market-based or economic instruments are aimed at motivating waste producers to divert waste from landfill or incineration preferably to material recovery (Morlok et al. 2017). This results in the optimisation of resource use and contributes to waste management services costs. The vehicles through which economic instruments are implemented are national or regional waste policies. These policies might include waste disposal taxes (landfill tax, incineration tax, product levies), waste pricing (pay as you throw (unit based), differential rates, variable rates), deposit refund schemes, extended producer responsibility, tradable permits, recycling subsidies and value-added tax exemptions for repair and recycling activities. An example of a local policy instrument that has environmental, social and economic impacts by providing incentives to low-income families, can be drawn from Curitiba, the capital of the State of Parana in Brazil. The city introduced a Green Exchange Programme in 1981. Families from the favelas, shantytowns and outside the reach of the city's dustcarts, could exchange waste bags for bus tickets and food. Children could obtain school articles, chocolates, toys and tickets for entertainment events in exchange for reusable waste. This programme alleviates hunger, generates income, preserves the environment and contributes to waste management. The local government trades with producers' associations organising small and medium producers through the Paraná Producers Federation. The Municipal Department of the Environment provides the budget for food purchases (Filho et al. 2016).

Negative incentives in the form of taxes in waste generation blocks may be approached in a nuanced way and advance environmental justice by introducing a tiered policy with differentiated taxes on the basis of inequality in a population (De Moraes Vieira and Matheus 2018). De Moraes Vieira and Matheus (2018) refer to the study by Chu et al. which demonstrated efficient reduction of waste generation when differentiated taxes were introduced in waste management blocks. The burden on low-income families is reduced.

A negative incentive in the form of high landfill tax, combined with a ban on landfilling of unsorted municipal waste and a deposit system was instrumental in the significant reduction of landfilling of municipal solid waste in Estonia within a period of only three years. The increase in landfill tax led to a significant increase in the landfill gate fee. This incentive was motivated by the Baltic state joining the EU in 2004 and the necessary transposition of EU directives. In addition, Estonia was the only new member state without a transitional period to comply with the targets set in the EU Packaging directive (Filho et al. 2016).

In developing countries with low income and high inequality, waste fees could be levied via Pay-as-you-throw policies in volume-based models (De Morais Vieira and Matheus 2018). This instrument flowing from the polluter-pays principle can be applied at municipal level by charging residents based on the waste amount sent to third party management (Morlok et al. 2017). PAYT approaches are also known as unit pricing, differential and variable rates, or variable fee charge systems. To implement PAYT, the waste producer must be identified, waste sent for treatment must be measured and unit pricing must be applied. Morlok et al. (2017) state that the waste fee must be calculated on the basis of the amount of waste generated (variable fee) and a basic or fixed fee, which deters illegal disposal. The implementation can take place in different ways: either by user identifier, per bin identifier or via pre-paid systems. Morlok et al. (2017) conducted a case study on the implementation of PAYT in the County of Aschaffenburg, Germany as representative of best environmental practice. The PAYT approach is a weight-based system that resulted in high collection rates of recyclables. Although low quantities of residual waste were reported, the implementation of PAYT did not significantly affect the long-term total amount of waste produced and managed by the county. The PAYT implementation cannot achieve significant waste prevention. Morlok et al. (2017) suggest that other policies are required for waste prevention such as product policies, waste prevention plans, tax regulations and, at local level, awareness-raising campaigns, reuse initiatives, second-hand markets and repair cafes.

Unit pricing can create an incentive for households to reduce the amount of waste disposed of at kerbside (Tait et al. 2005). Loukil and Rouached (2012) explain that the cost of the environmental damage is covered in the prices of goods and services which

cause it. Municipalities can demand a fee proportional to the weight or volume of the waste produced. Mechanisms to determine the individual's share of waste disposal include prepaid bags, onboard weighing or advance fixing of the size of waste containers (Loukil and Rouached 2012). In terms of the effect of unit pricing, households are firstly encouraged to reduce at source by purchasing products with low waste management costs. Secondly, diversion by means of recycling and composting is used to a greater extent, although they involve costs in terms of time and inconvenience. When unit pricing is introduced, it lowers the relative costs of recycling and composting, but may conversely lead to illegal dumping and burning (Tait et al. 2005; Loukil and Rouached 2012). The effect of unit pricing for municipal domestic waste collection and disposal was tested in Christchurch, New Zealand. The authors concluded that unit pricing in isolation would not be likely to reduce waste to landfill and that complementary programmes should be used in tandem with unit pricing. Provision of council bins, an expanded recycling programme and kerbside collection of organic waste would have a greater likelihood of reducing waste to landfill than unit pricing on its own (Tait et al. 2005).

Producers can also be taxed in terms of the weight and types of materials used in packaging (Loukil and Rouached 2012). This eco-tax on producers promotes innovation in product design and efforts to restrict quantities of waste in production, but it does not involve consumers in waste management in terms of collection and sorting separation (Loukil and Rouached 2012). Loukil and Rouached (2012) maintain that taxing policies should be complemented by other measures to involve households.

A deposit-refund system combines taxes and subsidies to encourage waste collection and involves consumers by promoting the return of packages in turn for a grant or a coupon (Loukil and Rouached 2012). The deposit-refund system is hampered by producer and distributor reluctance, who might anticipate lower sales because of the amount of the deposit. The increased cost of collection equipment and automatic machines also discourages support for this mechanism (Loukil and Rouached 2012). Loukil and Rouached (2012) recommend the use of a deposit-refund system in urban cities in the Middle East and North Africa (the MENA region) where there is a substantial amount of recyclable waste.

Apart from changing behaviour, negative incentives may also change the discourse around waste. A study by Gregson et al. (2013) conducted in the UK relates how unsold and unwanted goods were abandoned on site at the end of a car boot sale before the implementation of waste diversion and reduction policies in England. While site operators used to clear up the site, they opted to pass on the transaction costs and disposal to traders when the costs of disposal rose after steep increases in landfill tax. Currently site operators also adopt rhetorical means to promote reduce reuse and recycle principles by emphasising the value of waste through slogans like “Don’t Bin It, Sell It” or highlighting car boot sales as a mechanism to recycle and make money.

Negative incentives based on time consumption were also proposed in earlier literature (Godbey et al. 1998). If consumers perceive that recycling will take up less time than dealing with the sanctions for not doing so, it might increase effective waste management; for example, if supermarkets had express lines at supermarket checkout stations for consumers bringing their own containers for groceries. This would be an example of a recycling strategy taking into account people’s use of time and perceptions of feeling rushed.

In a study gauging the perceptions of waste management authorities regarding the implementation of economic instruments in solid waste management Nahman and Godfrey (2010) concluded that respondents supported economic instruments as a waste reduction measure. However, respondents felt that other aspects should first be settled, namely legislation, political will, education, awareness, developed capacity and infrastructure, cost recovery in waste management and enforcement. The authors recommend contextualised implementation of economic instruments, e.g. by incremental introduction or componential application in progressive stages to allow for gradual capacity development. A culture of compliance must predominate rather than one of illegal disposal, and a monitoring capacity must be developed.

Both government and the private sector can provide economic incentives in monetary form to encourage resource recovery (Mwanza et al. 2018b). Economic incentives could, for example, include waiving government taxes on recycling activities. Good waste management practices can also be promoted by launching competitions and offering

rewards for best practices (Ibrahim and Mohamed 2016). Mwanza et al. (2018b) refer to studies conducted by Agamuthu et al. (2007) and Yau (2010) which indicate that domestic recycling activities can be increased by economic incentives. However, a study by Owusu et al. (2013) conducted in urban households in Kumasi, Ghana, indicates that economic incentives in the form of cash to participate in solid waste separation were not on their own attractive enough to motivate respondents. Other factors such as perceptions on health and sorting, and the availability of open spaces in households also contributed to willingness to participate. In addition, the amount of cash that was persuasive would burden the public budget excessively and would be financially unsustainable for the municipality.

2.10.10.4 Voluntary-based Instruments

Although soft approaches are common in international environmental law, where regulation takes the form of non-binding resolutions, protocols, declarations, codes of conduct and guidelines, it is unusual in waste governance. The sector is normally regulated with laws, limit values, sanctions, incentives and public monopolies. In addition mandatory instruments such as landfill tax, landfill bans and producer responsibility encourage opting for choices higher in the waste hierarchy. Soft regulations have been successful where different actors are confronted with politically charged issues, and in times of uncertainty when laws need to be tested before developing into mature legal norms. Soft regulation is also characterised by political feasibility and flexibility (Johansson and Corvellec 2018). In a study on European and Swedish waste prevention plans, measures were found to be soft and included non-binding calls for further evaluation, promotion and co-operation, which came in the form of proposals. This approach to waste prevention contrasts sharply with the centralised planning used to control waste streams and emissions. Without incentives and sanctions producers and consumers decide on waste prevention and opt for approaches that suit them. In addition, non-governmental actors can provide alternative solutions by contributing their expertise, innovative practices, manpower, resources and knowledge. Conversely, control becomes weaker and the effect of waste prevention mechanisms becomes unclear (Johansson and Corvellec 2018). Another example of a voluntary based instrument can be found in the voluntary policies of European Sea Ports Organisation, which supports the improvement of environmental management at Brazilian ports such as the Environmental

Code of Practice 2004 and the Green Guide: Towards Excellence in Port Environmental Management and Sustainability (Jaccoud and Magrini 2014).

2.10.10.5 Extended producer responsibility

Extended producer responsibility (EPR) has the aim of motivating producers to design for the environment (DfE) (Wiesmeth et al. 2018). This could entail the use of less material, reusable or refillable containers and ease of recycling. However, since DfE impacts on demand, producers may not be eager to adopt the approach if it reduces demand. Producers hold information on the technical possibilities and costs involved, while policymakers do not have detailed information. Consequently, this asymmetry in terms of information necessitates the cooperation of producers and probably the motivation of the choice of appropriate policy tools to avoid a scenario where DfE only occurs when the market favours environmentally friendly designs. DfE without the integration of both consumers and producers into the EPR policy won't be effective.

Cooperation by consumers can be induced by incentives. Wiesmeth et al. (2018) investigated financial instruments such as deposit fees and advanced disposal fees. While a take-back system with a deposit fee provides an individual incentive and can increase return rates of packaging, a sophisticated infrastructure (the charge and return of deposit fees, a clearing house, and packaging return logistics) is required. Advanced disposal fees based on the estimated costs of collection and recycling does not encourage individual responsibility, but this instrument is frequently used. In the case of Georgia, a take back system with a deposit fee could raise incentive compatibility but would however be costly. The authors consider a combination of a separate waste collection system followed by a take-back system with a deposit for single-use plastics. In addition, the authors review the individual implementation system which transfers the obligation to producers and incorporates the polluter-pays principle, but it is costly and may be useful where products are supplied in a geographically limited area or where chain stores set up their own system. They find that this system accommodates vested interests conflicting with environmental concerns and would be too costly as an alternative for Georgia.

In terms of collective implementation systems discussed in the case study (Wiesmeth et

al. 2018), there is a choice between for profit and non-profit producer responsibility organisations and collective systems based on associations vs collective systems based independent compliance schemes. The association as a collective implementation system realises the polluter-pays principle and economies of scale lead to a reduction of collecting and recycling costs. Challenges include the sharing of costs or profits, a critical view of new entrants, lack of an incentive for quality of service, limited possibility for input from public authorities, problems in extending associations to other areas of waste management and vested interests. Compliance schemes are private companies, certified and accredited by public authorities, and have the benefit of independence from producers. The scheme's revenue source is licence fees for the handling of waste packaging. The fees are impacted by the competition between compliance schemes. With compliance schemes the vested interests of producers are mitigated or abolished and DfE is incentivised to lower licence fees to be paid to the scheme. Wiesmeth et al. (2018) recommend a collective system based on independent compliance schemes for Georgia.

Wiesmeth et al. (2018) also categorise EPR systems in Germany, Austria, Bulgaria and France. Drinks packaging is subject to a collective system based on a take-back system with mandatory deposit fees and some independent compliance schemes. Competitive system collecting, sorting and recycling also take place, which lead to reduced waste package handling costs. In Austria some compliance schemes operate in competition with each other. There is no mandatory deposit fee for single-use plastic drinks containers. In Bulgaria separate collection, recovery and recycling is catered for by the packaging directive. Although systems operate, they are inefficient due to lack of control from public authorities and a lack of incentives for both citizens and small retailers. In France there is one compliance scheme for packaging waste which operates as a non-profit organisation. However, there are other separate EPR systems dealing with other parts of household waste. Command policies prohibit single-use plastic bags. The system is not optimal. Wiesmeth et al. (2018) conclude that a competitive system of independent compliance schemes is important, that a take-back system with deposit fees plays a valuable role, that a clear policy of control by public authorities is significant and that EPR should be simple to manage.

Some of the literature recommends adopting extended consumer liability as a model for

all countries to minimise the generation of e-waste, based on the Basel Convention. However, the economic, environmental and social situation in developing countries generally differs from that of developed countries and therefore technologies suited to local conditions should be adapted, implemented and scaled up. In addition, stakeholders responsible for e-waste production and disposal have to support the model and stakeholders should address the issue of the production, storage and disposal of e-waste (Kitila and Woldemikael 2019).

In Tunisia a national collection system of packaging waste recovery and collection (ECOLEF) is based on the polluter-pays principle (Loukil and Rouached 2012). Through membership of ECOLEF companies enjoy the right to use the logo of the organisation and contribute to the creation of employment in collection, sorting and recycling.

Environmental fields where EPR has been implemented include packaging waste, WEEE (for example in China, Japan, Germany, Switzerland and Europe) (Wiesmeth et al. 2018).

2.10.11

Waste picker integration and formalisation

Waste picking provides a critical source for livelihood and waste pickers play an important economic and environmental role in cities (Nzeadibe et al. 2012; Dias 2016), particularly in contexts where neoliberal policies prevail, as in Nigeria, and waste picking has increased (Nzeadibe et al. 2012; Nzeadibe and Mbah 2015). Furthermore, inclusion of waste pickers in municipal solid waste management can be conducive to reaching the UN's Sustainable Development Goals by saving money and landfill space, driving entrepreneurship, generating employment and incomes, mitigating climate change, creating a green economy and conserving non-renewable resources (Nzeadibe 2009; Nzeadibe and Mbah 2015; Mbah and Nzeadibe 2017). They can also make a valuable contribution to waste management planning in terms of their practices and experiences (Nzeadibe 2009). However, their contribution, in particular to the environment, public health and urban economies, is ignored (Medina 2000; Nzeadibe and Anyadike 2012; Dias 2016). They also experience different levels of vulnerability connected to their place of birth and sense of belonging and the fact that a large percentage of waste pickers do not relate their health and safety problems to waste picking (Nzeadibe et al. 2012). They

do, however, show evidence of agency. They contest misleading perceptions about their livelihoods, conventional approaches to urban planning and continuously mobilise to be included in laws and policies, and to achieve efficient management of their services (Dias 2016). Dias (2016) argues that waste pickers should be granted access to waste as a common-pool resource, provides a model affirming the central role of waste pickers and integrates them into the waste management system as key actors. Dias (2016) also represents their contribution as participative rather than consultative in a system where waste is multidimensional. Her model focuses on technical, social, institutional and environmental aspects of waste and has three components: governance, physical elements and an enabling environment. Cities demonstrating the feasibility of her model, like Belo Horizonte in Brazil, for example, provide agreements and contracts that safeguard access and payment for waste (Dias 2016).

An integrated approach to waste management takes into account the role of all stakeholders within the framework of the relevant economic, social, institutional and environmental context of the solid waste management system, as well as the integration of a large diversity of stakeholders (Matter et al. 2013; Mbah and Nzeadibe 2017). Therefore, the role of the informal sector is also significant. In a study on the determinants of environmental behaviour of the urban poor concerning waste management in Kuala Lumpur, Malaysia, Murad and Siwar (2004) recommend that informal waste pickers be incorporated into the formal waste sector. In developing countries such as Ghana, the integration of informal waste collectors like waste pickers, waste recyclers, scavengers and waste carriers is recommended since they contribute to environmental management (Boadi and Kuitunen 2003). Belo Horizonte, the capital of the state of Minas Gerais, is an example of a developing country where public policy prioritised the integration of waste pickers (Filho et al. 2016). This is related to the regional tradition of dialogue and active community participation, the strong political commitment and involvement of the community in participatory planning of waste management. Legislative provision was made for environmental education programmes and technical advice to waste pickers and new waste pickers also have access to capacity-building courses covering topics like recycling, human relations, traffic security and literacy. A second aspect of the policy pertains to the awareness raising in the community of the contribution of waste pickers to waste management. Carnival parades, theatre, dance and music were used to enhance

awareness. Thirdly, all stakeholders including waste pickers and NGOs were involved in participatory planning in discussing guidelines for the integration of waste pickers into the waste management system and challenges regarding public financial resources. The association of individual collectors and other waste pickers' organisations formed a group that worked in the first plastic recycling plant in Latin America. Integration of waste pickers through education, participation and collaboration is a positive feature of the waste management system in Belo Horizonte. Earlier research on waste pickers in Latin America also highlighted the role of scavenger cooperatives in striving for a better living standard, dignifying the waste picking occupation and strengthening their bargaining power with industry and the authorities (Medina 2000).

Barriers to formalisation include institutional/organisational, policy/legal, financial/economic, social and technical issues. If they are not addressed, they have the potential to become persistent after the implementation of formalisation, sometimes due to negative conditions particular to the country. Although the study did not identify a formalisation approach with the most potential for success, country-appropriate measures especially on policy, economic and institutional level were significant in increasing success as well as the empowerment of formalised waste –workers (Aparcana 2017). In a literature review of informal waste management in Nigeria, repressive policy, unhygienic waste collection methods, lack of evidence to support activity and low quality and quantity of secondary materials were identified as barriers hindering inclusive waste management (Oguntoyinbo 2012). Fahmi (2005) in a study investigating the privatisation of local solid waste management in Cairo, shows how business interests are favoured and those of the local population is threatened and highlights the importance of access to a sustainable flow of local resources for Zabaleen or traditional waste collectors. Barriers to access seem to be access to clean recyclables of higher value and negative preconceptions about the role of waste pickers (Matter et al. 2013). Another significant barrier was identified in a study conducted in Bandung, Indonesia, by Sembiring and Nitivattananon (2010). The authors point out that the integration of the informal sector is a complicated matter, since decision makers have to balance the improvement of collection and technology which would limit the contribution of the informal sector, with the contribution of the informal sector to solid waste management and their basic service needs and social rights. Addressing these concerns requires perception changes and the strengthening of

partnerships in the informal sector (Sembiring and Nitivattananon 2010). Simatele et al. (2017), in a study on the informal sector in Johannesburg, also indicate that negative perceptions about waste pickers as a nuisance within the context of the urban environment, contributing to littering of solid waste hinder integration. The authors also suggest a perspective shift towards more inclusivity and collaboration between the public and private sector (Simatele et al. 2017).

Understanding the needs and perceptions of stakeholders integrated into the waste management system is key to improving processes. In one of the early studies Rogerson (2001) underlines the need for support of the growth of emerging SMMEs in the waste economy and points out in particular that innovation micro-credit programmes might play a role. Murad and Siwar (2004) propose that waste pickers be provided with sanitary working conditions and be rewarded for waste reduction and for recycling efficiently, including timely execution. Other developmental interventions suggested as part and parcel of integration include support for the formation of scavenger co-operatives by grant provision, strategic advice and guidance to promote successful operation, development of markets and recognition at policy level (Nzeadibe 2009). Interventions to foster integration should foster a sense of ownership and commitment in all stakeholders, increase awareness of the benefits of waste segregation and provide support in facilitating behaviour change through establishing better facilities, provision of equipment and improving service reliability (Matter et al. 2013). Other measures to promote inclusion and participation include social innovation initiatives, policy-level recognition, legislative and institutional reforms, advocacy to change behaviour and attitudes toward the sector and capacity development (Nzeadibe and Anyadike 2012). Policy measures to promote inclusion of waste pickers in Nigeria include taxation of new products, subsidisation of recycled products to encourage reuse and recycling, setting targets for recycling and the use of recycling products, introducing buy-back schemes, legislative reforms in terms of formal recycling, developing functional source separation schemes and public-private partnerships in solid waste management (Mbah and Nzeadibe 2017). In a study on the integration of informal waste pickers conducted in Iloilo City, in the Philippines, a comprehensive approach to integration was proposed (Paul et al. 2012). Waste characterisation could lead to new recycling opportunities and contribute to the livelihoods of the waste pickers. Stakeholder analysis could highlight support as well as opposition,

and serve as a basis for linking joint projects and networks. A project management team to manage integration is advised. Waste pickers should be prepared for additional material recovery and related pilot projects should be launched. A waste workers association could provide membership benefits such as identification cards, capacity building, health services and micro-insurance and/or financing programmes. Registration support, support for a managing board, and drafting of strategies and working policies as well as workshops could strengthen the association. New recycling products of the association could be marketed and additional livelihood opportunities offered. Highlighting best practices and successes could enhance the visibility of the informal waste pickers and stimulate further development support. Finally, educational opportunities for waste worker children could promote their progress and prospects for future employment (Paul et al. 2012). Mbah and Nzeadibe (2017) argue that the informal economy should be mainstreamed and that this would be financially beneficial, economically efficient, socially inclusive and environmentally sustainable.

In a study focusing on Amritsar City, Punjab, India, Sandhu et al. (2017) propose two models for the integration of informal waste pickers against the background of the threat of privatisation. Both models rely on waste pickers for door-to-door collection as well as sorting and recycling. In addition, both models propose a composting unit for organic waste as a waste-to-energy option if primary separation of waste is achieved. The models differ in terms of the stakeholder responsible for collection from secondary storage bins, transportation and disposal. Model A, involving the municipality and the informal waste sector, allocates the responsibility for collection from secondary storage bins, transportation, and disposal to the municipality. Model B, involving a private company and the informal waste sector allocates the responsibility for these actions to a private company. In both models there are no social displacements and livelihood-based recycling continues. In the case of model A, organic waste composting is promoted by the municipality on its own or on a private contract basis. In the case of model B, the private company still gains from the tonnage and organic composting unit operations. In model A the municipality's image is promoted while in model B the private company's corporate policy of social responsibility is boosted, since it respects the customary rights of the waste pickers (Sandhu et al. 2017).

In South Africa waste picker integration has been extensively investigated and conceptually developed in the *Waste Picker Integration Guideline for South Africa* (Department of Environment, Forestry and Fisheries and Department of Science and Innovation [DEFF] 2020) and promoted through legal developments regarding extended producer responsibility. Literature advocating for the recognition and inclusion of waste reclaimers includes, for example, the work of Samson (2015), Schenck and Blaauw (2011), Schenck et al. (2016) and Grobler and Schenck (2021).

3. Chapter 3: Littering

3.1 Introduction

Internationally, there is an abundance of literature on littering. Nevertheless, there is a dearth of studies on littering in most developing countries (Chaudhary et al. 2021) and in the Palestinian territory (Al-Khatib et al. 2009). Furthermore, Chaudhary et al. (2021) note that previous literature reviews on littering focus on developed countries, but affirm that research involving developing countries is important because they are significantly impacted by littering and solutions generated in developed countries may not be generalisable to developing countries. African countries are also underrepresented in studies. Chaudhary et al. (2021) include only a few studies from Nigeria and Ghana. Littering studies have also been done in the Gambia (Farage et al. 2021), Zimbabwe (Tanyanyiwa 2015; Zambezi et al. 2020) and South Africa (Govender and Reddy 2020; Matsekoleng and Awshar 2020; Schenck et al. 2021a, 2021b; Matsekoleng 2021). There is still ample room for research on littering in the South African context, given that the country experiences major issues with undesirable waste disposal practices (Garg and Mashilwane 2015).

Wever et al. (2010) highlight three main research focal points. Firstly, research has been conducted on the amount, compilation and location of litter in specific areas; secondly, studies on the behaviour leading to litter are prevalent, and lastly, the literature on the effectiveness of interventions aimed at reducing littering has addressed solutions to the waste issue. This literature review will not focus on the first research aspect but on the last two.

Littering has been defined as the careless and improper disposal of small amounts of waste that results in unwanted and unnatural elements remaining in the environment (Al-Khatib et al. 2009; Ojedokun and Balogun 2011; Khawaja and Shah 2013). Litter is classified as a special subcategory of municipal solid waste and is distinguished from other subcategories, since it is not disposed of in proper receptacles. It may include solid or liquid domestic or commercial refuse, debris or rubbish. Common examples include soft drink bottles, glass, metal, cigarette butts, small pieces of paper, fabric, chip and confectionary wrappers, fast-food packaging, bottle caps, other bottles, plastic straws, wood, food, abandoned vehicle parts, construction or demolition material, garden

remnants and clippings, soil, sand or rocks (Al-Khatib et al. 2009; Ong and Sovacool 2012; Schultz et al. 2013). Moreover, new forms of litter emerge increasingly and have, for example, been linked to changing consumer patterns in terms of take-away food and the increase in unsolicited advertising materials (Al-Khatib et al. 2009). A wider notion of litter might entail any other material, substance, or thing, regardless of origin, deposited in an unacceptable place or dislocated from its destination. In particular, this would be the case if the size, shape, nature or volume of the litter cause the place to be deemed disorderly, or if it detrimentally affects the proper use of that place, whether or not it has any value when or after being deposited (Al-Khatib et al. 2009; Schultz et al. 2013).

Cigarette butts are perceived to be the most abundant litter category in the world (Carmi 2019) and especially in urban areas (Hietler and Pladerer 2020, drawing on Gerlach). In terms of primary types of litter, Al-Khatib et al. (2009) have indicated that cigarette butts, glass bottles and food waste comprise the largest portion of litter in the Nablus district in the Palestinian territory. Cigarette butts are also the item littered most frequently in the USA (Rath et al. 2012).

Determining the source of litter affects the selection of management strategies. Some types of litter, for example, can be ascribed to a combination of anthropogenic activities and transportation, as well as dislocation by natural phenomena. Beach litter can be attributed to land-based sources, but is often deposited by the sea as a consequence of shipping, recreational boating, navigation, fisheries, aquaculture and other offshore activities, and accounts for a higher percentage of litter than deposits by beach users (Watts et al. 2017). Although dislocation is also a source of litter, research has pointed to individuals being a major source of litter (Schultz et al. 2013). Changes in health policies such as mandating protective equipment including fitted face masks and latex gloves also emerged as a recent source of litter during the pandemic, as evident from a study conducted in Albury, regional Southern New South Wales, Australia (Spennemann 2021) and in a study on face mask littering in Bangkok, Thailand (Tsfaldet et al. 2022).

Some research has concluded that littering behaviour is more prevalent among males (Al-Khatib et al. 2009; Beeharry et al. 2017), young adults (Muñoz-Cadena et al. 2012; Beeharry et al. 2017;) and individuals in rural communities (Schultz et al. 2013; Beeharry

et al. 2017;). Schultz et al. (2013) caution that these results are not conclusive and that many studies could not identify significant demographic predictors. Hietler and Pladerer (2020), drawing on the work of Gerlach, found that littering is especially prevalent among smokers and that littering is most likely to happen in groups and in public. Other factors related to littering and anti-littering behaviour include educational level, religious conviction and worldview, income, marital status, urban stress, local identity (Al-Khatib et al. 2009; Beeharry et al. 2017; Meloni et al, 2019;). Married individuals and widow(er)s report that they litter less than divorced or single individuals (Al-Khatib et al. 2009). Pedestrians and motorists contribute extensively to littering (Noah 2002).

Conversely, urban stress and sustainable worldviews predict anti-littering behaviour. City identity acts as a moderator of the relationship between urban stress and non-littering. When stress levels are high, anti-littering is likely for those with strong local identity (Meloni et al, 2019).

3.2 Impacts of litter

Initially litter was perceived as primarily an aesthetic issue, but it has become recognised as a broader environmental problem (Al-Khatib et al. 2009; Ong and Sovacool 2012). Litter impacts on the environment significantly by causing aesthetic blight, health hazards such as food safety issues due to microplastics in food, injuries caused by broken glass and beach litter or ingestion (Hietler and Pladerer 2020), infection by pathogens in discarded hypodermic needles and rotting contents of bottles and tin cans, breeding habitats for insects, attraction of rats, roaches and mosquitoes. It leads to habitat adaptation in certain animals such as spiders who exploit discarded containers (Kolenda et al. 2021), death and danger to livestock and wildlife, and toxic gases and residues (see, for example, Mohajerani et al. (2020) and Oliva et al. (2021) on the impact of cigarette butts). It also decreases soil productivity, creates risks of flooding and fire, and leads to decreased biodiversity and ecosystem functioning, increased refuse collection and related costs as well as loss of amenities (Njeru 2006; Al-Khatib et al. 2009; Muñoz-Cadena et al. 2012; Ong and Sovacool 2012; Khawaja and Shah 2013; Schultz et al 2013; Campbell et al. 2016; Carmi 2019; De Francesco et al. 2019; Aretoulaki et al. 2021; De Sadeleer et al. 2021; Ojedokun 2015). It impacts on crime rates (Hilburn 2016). Litter also leads to the pollution of surface and ground water and contributes significantly to the

transmission of diseases such as dengue and leptospirosis (Rath et al. 2012; Khawaja and Shah 2013). It may cause vehicle accidents (Khawaja and Shah 2013). Furthermore, the presence of litter can lead to additional littering (Khawaja and Shah 2013). Litter also has an economic impact in terms of the costs involved in litter collection (Hietler and Pladerer 2020) and the economic losses associated with the litter present in public places (Al-Khatib et al. 2009; Cingolani et al. 2016; De Francesco et al. 2019; De Sadeleer et al. 2021;), decreased residential property value, reduced sales and decreased customer numbers in commercial areas (Ong and Sovacool 2012; Schultz et al. 2013), failure of tourism (De Francesco et al. 2019) and, in the case of marine plastic litter, affects marine-based sources of income (e.g. fishing, aquaculture, marine tourism and merchant shipping) by compromising economic development (Aretoulaki et al. 2021).

From an ideological point of view, the unequal distribution of litter, such as plastic bags, and the unavailability of municipal services including solid waste disposal signal environmental injustice that can be related to the inequalities of colonialism (Njeru 2006).

In terms of socio-psychological effect, a causal relationship exists between observing litter and a number of aspects. These include the anticipation of both physical incivilities such as “low-level breaches of community standards that signal an erosion of conventionally accepted norms and values” (LaGrange et al. 1992: 312) including litter, graffiti, vandalism and vacant or dilapidated buildings, as well as social incivilities, including anti-social behaviour, begging, youth gangs, drug and alcohol abuse, as well perceptions of crime prevalence (Medway 2016).

3.3 Reasons for littering

In a study by Awunor et al. (2021), the socio-demographic and behavioural determinants of littering in Benin City, South Nigeria were investigated. A significant association was found between littering tendencies and age, gender and educational status (Awunor et al. 2021). A study by Aziz et al. (2019) focusing on littering in greenspaces, and in particular Pantai Temasya, Sarawak, a recreational park in Malaysia, related littering directly to socio-economic characteristics. More male than female respondents, more Chinese respondents and more singles and childless respondents admitted to littering (Aziz et al. 2019). In terms of age, a higher percentage of littering was indicated for those

in the age group 17–25. In addition, a lower education level was associated with littering, since those respondents who only completed primary school tended to litter more (Aziz et al. 2019). Al-Khatib et al. (2009) also found a direct relationship between littering and the socio-economic characteristics of gender, family income, marital status and religious convictions. Norrgren and Swahnberg (2016) also found that personal traits influence prosocial behaviour. In the study an increase in age was associated with a decrease in littering. An increase in education coupled with an increase in age also indicated decreased littering in a study by Norrgren and Swahnberg (2016). However, the findings of a study in Jordan indicated that both young respondents and those aged 50 and over littered more than other age groups (Moqbel et al. 2019). In studies by Akpoghiran (2020) focusing on Benin City, Edo State, Nigeria, and by Moqbel et al. (2019) conducted in Jordan, findings indicate that a low level of environmental education or a lack of anti-littering education is one of the reasons for, or perceived reasons for, (Schenck et al. 2021b) littering.

Almosa et al. (2020) attributed littering partly to social norms. Littering, in a study by Amankwah-Poku and Ofori (2020) conducted among university students at a university in Ghana, was found to be normal. In a study conducted in Jordan, respondents also indicated that they considered littering to be acceptable in the country and that consequently, this norm might be a justification for littering even though respondents may not be pro-littering (Moqbel et al. 2019). Aretoulaki et al. (2021) ascribed the increase in marine plastic litter to the throw-away culture with its over-consumption and excessive production of disposable products. Cultural customs such as the notion of honouring bread in Middle Eastern countries, that is to dispose of leftover bread (whether dry or spoiled) separately from municipal household waste, so that stray animals or cattle may feed on it, were also noted in a study conducted in Jordan (Moqbel et al. 2019).

Some scholars attribute littering to individual beliefs and characteristics. Amankwah-Poku and Ofori (2020) found that littering is the outcome of shifting the responsibility for waste disposal onto others, including the government, paid workers and waste management organisations in Ghana. A similar belief that litter cleaning was not the job of the litterer was evident in a study conducted in Jordan (Moqbel et al. 2019). A belief that littering creates jobs for street cleaners was also noted in South African studies on street vendors

in Mankweng Township and Paarl as well as commuters in Paarl (Schenck et al. 2021a; Schenck et al. 2021b). Laziness was one of the reasons identified by Khawaja and Shah (2013, drawing on Ojedokun and Balogun 2011; Muñoz-Cadena et al. 2012) and stated as a perceived reason for littering by participants (Schenck et al. 2021a; Schenck et al. 2021b). A lack of concern about a healthy environment and a poor culture concerning environmental behaviour originating in the home and a poor attitude relating to environmental management were identified as reasons by Akpoghiran (2020). In addition, reluctance to hold on to litter because it is considered dirty contributed to littering (Amankwah-Poku and Ofori 2020). Similarly, De Sadeleer et al. (2021, drawing on Wever et al. 2010) also note the “disgust factor” involved in picking up and disposing of cigarette butts is related to the high littering rate of this product. Attitude was also identified as a key factor in littering (Aziz et al. 2019). Imitation was also cited as one of the reasons for littering (Muñoz-Cadena et al. 2012; Amankwah-Poku and Ofori 2020).

According to Almosa et al. (2020), a lack of knowledge contributed to littering on an individual level. Akpoghiran (2020), in a study conducted in Benin City, Nigeria, found that the majority of participants were not aware that littering could lead to environmental hazards or impact negatively on the aesthetic beauty of the environment. Rodríguez-Rodríguez (2012), in a study investigating litter in protected areas of the Autonomous Region of Madrid, citing McKercher and Weber (2008), Brown et al. (2010) and Chang (2010), also mentions deficient environmental consciousness and urban origin as further causal factors. A related reason for littering, identified in a study on cigarette littering, is that people who litter may not regard the item being littered as litter. In particular, some smokers do not consider cigarette butts to be litter, especially where cigarette filters were not frequently observed in the environment (Rath et al. 2012). Poor and inconsistent sensitisation by the media is a related reason for littering identified by Akpoghiran (2020).

Littering is also correlated with the number of people frequenting a site and different visiting or traffic or use patterns during the day or season. Several studies indicate that fluctuating patterns of traffic during different times of day are positively correlated with the amount of litter generated (Noah 2002). Noah (2002), in a study on the environmental impact of the taxi industry in Butterworth, South Africa, observed a direct relationship between passenger numbers and ground pollution. Face-mask littering was also found to

be related to areas with high traffic such as mass transit stations and busy areas of streets in a study in Bangkok, Thailand (Teskaldet et al. 2021). Similarly, in a study on the extent of cigarette butt litter in an urban environment in Madrid, Spain, researchers found that higher volumes of cigarette butts were found in central districts with more hospitality venues and public transportation stops (Valiente et al. 2020). Beach litter is also impacted by factors that may vary with location and season (Watts et al. 2017). A higher volume of litter during afternoons in lecture classrooms was associated with other uses of classrooms such as waiting for lectures, studying and consuming food (Malomo et al. 2021). The built environment can also be a determinant of littering (Almosa et al. 2020). Some authors attributed littering to a lack of litter bins in streets (Al-Khatib 2009; Muñoz-Cadena et al. 2012; Rodríguez-Rodríguez 2012; Beeharry et al. 2017; Freije, Naser and Abdulla 2019; Amankwah-Poku and Ofori 2020). The lack of proximity of bins and recycling receptacles were also noted as a reason in studies by Moqbel et al. (2019) and Amankwah-Poku and Ofori (2020). Importantly, in the study by Moqbel et al. (2019) the physical appearance and design of waste containers were also related to littering behaviour. Moreover, when these receptacles evoked feelings of disgust and a fear of sickness, respondents also indicated the likelihood of littering (Moqbel et al. 2019). In South African studies conducted in Paarl and Mankweng Township the appropriation of and damage to waste receptacles, the low visibility or lack of waste containers and the ill-suited character of waste containers all contributed to littering (Schenck et al. 2021a; Schenck et al. 2021b). The study in Paarl and Mankweng also indicated that inadequate sanitation infrastructure was related to littering (Schenck et al. 2021b).

The behaviour of and ineffective waste management by local authorities can also be related to littering. Muñoz-Cadena et al. (2012) found that municipal authorities were not vigilant enough in a study conducted in a Mexico City neighbourhood. In a South African study conducted on eThekweni Municipality's regeneration programmes on littering and dumping, the authors also found that littering along with dumping were the outcomes not only of a lack of compliance with regulations but of limited enforcement, service levels, a lack of monitoring and evaluation of regeneration programmes (Govender and Reddy 2020). In a study conducted in Paarl and Mankweng Township, South Africa, both the presence of cleaners (allowing a shifting of responsibility to cleaning staff) and the absence of cleaners were related to littering (Schenck et al. 2021b). An important reason

stated by participants in a South African study in Paarl was that littering was an expression of discontent with a government perceived as uncaring (Schenck et al. 2021a).

Causes of increased littering have also been noted. Al-Khatib et al. (2009: 450) mention a lack of social pressure in terms of litter prevention, the absence of “realistic penalties or consistent enforcement, social rebellion, and lack of knowledge of the environmental effects of littering”. The high private costs of correct litter disposal also increases littering (Khawaja and Shah 2013). The presence of litter can also lead to further littering (Weaver 2015; Sharma et al. 2019; Amankwah-Poku and Ofori 2020). This causal relationship is related to the influential “broken windows” theory. According to this theory, disorder cues in neighbourhoods are triggers for antisocial behaviours such as littering (Volker 2017). Volker (2017), however, indicated that the effect of these cues is not as pronounced as originally postulated and that neighbourhood and individual characteristics play a moderating role. Similarly, a study conducted by Malomo et al. (2021) in a classroom setting at a university campus in Lagos, Nigeria, did not confirm the broken windows theory but pointed toward other underlying behavioural challenges. The authors suggested that a poor maintenance culture, habitual practices as a result of childhood socialisation and subconscious littering may contribute to littering (Malomo et al. 2021).

Both the product and its packaging design can also play a role in littering. De Sadeleer et al. (2021), drawing on Wever et al. (2010), also noted that the shape of littered items and their small size have an impact on littering. Moreover, eco-feedback appearing on anti-littering labels as well as the reusability and reclosability of items (i.e. the property of an item allowing it to be closed again) play a role (De Sadeleer et al. 2021). Badly designed packaging of commercial products, the amount of litter at a particular location, the presence and wording of littering signs and the amount, the poor placement and appearance of waste disposal bins also contribute to increased littering (Al-Khatib et al. 2009). The increased use of plastic in product packaging was also cited as a reason for littering in a study by Beeharry et al. (2017) conducted in Grand Baie, Mauritius.

It is important to note that the reasons for of littering are dependent on the region and culture, and therefore the success of littering-prevention programmes hinges on a context-based investigation utilising a cross-disciplinary approach and community

participation (Al-Khatib et al. 2009; Muñoz-Cadena et al. 2012). This is also the case for marine litter. In a Tasmanian study the main cause of marine debris deposition has been identified as local marine transport of debris from upstream sources to downstream shores. Other significant sources of litter were direct littering by beachgoers and transport from surrounding areas via storm water drains and coastal runoff (Willis et al. 2017). As Willis et al. (2017) note, it is important that debris should be dealt with at the local level.

3.4 Attitudes towards littering

Research on the correlation between attitude and littering is scarce (Ojedokun 2011). An individual's attitude towards littering refers to the psychological tendency to evaluate or react towards littering with favour or disfavour and encompasses cognitive, affective and normative dimensions (Ojedokun and Balogun 2011). A negative attitude towards littering may be perceived as signifying a "culture of cleanliness and community shared responsibility" (Ojedokun and Balogun 2011: 69). Public attitude studies about street littering are important for the process of identifying administrative and strategic priorities (Al-Khatib et al. 2009).

Studies on attitudes towards littering indicate that the generation of recyclable litter relates to consumer preferences in terms of the frequency and types of waste. Interestingly, although people are aware of the negative impact of litter, they still engage in littering, as illustrated in a study conducted in Mexico City by Muñoz-Cadena et al. (2012).

In a study conducted in Ibadan, Nigeria, Ojedokun (2011) found that individuals who have certain desirable personality characteristics such as altruism, an increase in locus of control and have a disapproving attitude towards littering, would be more prone to engage in pro-environmental behaviour. In addition, Ojedokun and Balogun (2011) in another study in Ibadan, Nigeria, concluded that apart from altruism and locus of control, environmental self-efficacy² and self-concept contribute significantly to an individual's negative attitude towards littering.

²Environmental self-efficacy is defined by the authors as "confidence of an individual in his or her ability to successfully perform behaviours that can solve environmental problems in the face of different barriers" (2011: 71).

3.5 Perceptions about littering

Research shows that behaviour is based on perceptions of reality (Dijksterhuis and Van Knippenberg 1998; Beeharry et al. 2017). Therefore, the analysis of public perceptions of litter is important, since there is a significant link between litter and individual behaviours (Carmi 2019) and hence understanding perceptions is one of the primary steps in developing a comprehensive and sustainable anti-littering approach (Hartley et al. 2015; Beeharry et al. 2017). Building on these notions, Beeharry et al. (2017) in their study on anti-littering behaviour of coastal users, posit that improving perceptions could advance anti-littering behaviour. As a starting point within the context of this study, it is therefore important to determine perceptions around litter and littering before behaviour is addressed. Nevertheless, it should be noted that there is a difference in perception between perceived estimation of litter generation and observed estimation by researchers, as indicated by Hilburn (2016) in a study conducted in a rural municipality in Mexico. An inaccurate perception of littering may therefore influence pro-environmental behaviour. Other factors may also influence perceptions of littering. Perceptions of various groups, for example, different coastal user groups, differ as is suggested by a study conducted in Grand-Baie, Mauritius (Beeharry et al. 2017). In this study perceptions regarding aspects of marine litter (e.g. severity, constituents, contributing factors, litter dispersion paths, distribution at sea, user group contribution, threats, responsibility) were investigated and linked to various coastal user groups such as inhabitants, fishers and hawkers as well as visitors. Some stimuli influence the perception of cleanliness of in-house and corporate facility managers. Stimuli include actual cleanliness, staff behaviour, the condition of the environment, scent and appearance of the physical environment (Vos et al. 2018). A study conducted in Brazil by Krelling et al. (2017) also found that beach users with varying socio-economic profiles (income, education, daily expenditure, frequency of travel to beach areas and period of permanence in area) in different beaches with different environmental settings have different perceptions of environments containing marine debris. In a study by Rayon-Viña (2019) comparing perceptions of beach litter among beach cleanup volunteers and other beachgoers, volunteers perceived more litter on beaches.

Some research focused on specific target groups, for example, children or the marginalised and poor, in terms of perceptions of litter (Hartley et al. 2015; Carmi 2019).

Researchers view the perceptions of children as strategically important because they also represent future actors and have social influence on their peers, parents and the community (Hartley et al. 2015). As Carmi (2019) notes in a study conducted in Kus-A-Zarqa, Israel, the sites inhabited by the marginalised, poor and undeveloped communities can be important conservation sites.

In terms of responsibility, one study notes that street cleanness is viewed as a shared responsibility of citizens and local authorities (Al-Khatib et al. 2009). Willingness to volunteer in street-cleaning campaigns can be linked to a strong sense of belonging that community members experience in relation to their local public places (Al-Khatib et al. 2009). A study on beach clean-ups in the south Bay of Biscay noted an association between higher knowledge levels regarding beach litter and participation in beach cleanups (Rayon-Viña 2019). However, perceived knowledge of litter-related problems may not necessarily change behaviour. In terms of consumer practices, plastic bag use was perceived as a problem by a majority of respondents, but they nevertheless opt for the use of plastic bags because of the convenience, as indicated in a study conducted in South Africa (O'Brien and Thondhlana 2019).

3.6 Anti-littering strategies

3.6.1 Introduction

The identification of effective interventions that reduce littering behaviour remains important because it can potentially result in “large and synergistic benefits” (Bateson et al. 2015: 1). This section reviews the research literature generated on anti-littering strategies.

From a historical point of view, research on anti-littering strategies has shown a marked paradigm shift during the last half century. During the 1970s the research emphasis in environmental pollution studies shifted from sociological and personological surveys and/or correlational studies towards an experimental mode centred on behaviour manipulation (Baltes and Hayward 1976). In this regard, anti-littering behaviour refers to actions and mannerisms performed with the aim of impacting positively on the environment by decreasing litter (Beeharry et al. 2017). As a result of the shift in research emphasis, the acquisition, maintenance and modification of pollution behaviour and in

particular littering or non-littering behaviours were conceptualised as being governed by principles similar to those of other learned behaviours (Baltes and Hayward 1976). Treatment strategies such as positive reinforcement, positive prompting, negative promoting and the provision of litter containers were evaluated. Since the research paradigm shift, many studies in developed countries have investigated and evaluated strategies to reduce littering by behaviour control. Compared to research in developed countries, studies on littering behaviour in developing countries are comparatively scarce (Al-Khatib et al. 2009).

Researchers have distinguished between two main types of behavioural strategies to minimise littering, namely antecedent and consequence strategies. Antecedent strategies aim to have an effect prior to generation of litter (Huffman et al. 1995; Wever et al. 2010). They may include prompts / verbal or written messages, awareness / education, modelling or demonstrations, goal-settings or commitment strategies, engineering or design procedures (Huffman et al. 1995, citing Geller et al. 1982; Hing and Gunggut 2012). Examples might include cleaning up litter in a location to prevent new litter, adjusting the number, design and placement of garbage waste receptacles, and communication strategies promoting anti-littering behaviour. Communication strategies could range from direct anti-littering messages, to general public campaigns and educational programmes (Huffman et al. 1995; Wever et al. 2010). Consequence strategies concentrate on the period after litter generation and could include punishments (such as fines) or rewards (in the form of, for example, a deposit or lottery opportunity). The effects of rewards as a subcategory might, however, be countered by the costs involved in the implementation of the consequence strategy (Huffman et al. 1995; Wever et al. 2010; Hing and Gunggut 2012). Both these strategy clusters were noted to be effective in litter reduction (Hing and Gunggut 2012).

Although the taxonomy of antecedent and consequence strategies which was coined by Geller (Geller et al. 1982) provides a useful and accepted point of departure for classifying anti-littering strategies, the focus on behavioural approaches and behavioural procedures to effect changes does not provide a comprehensive anti-littering strategy taxonomy that takes into account other strategies (compare Tapp 1980; Willems and McIntire 1982). Other strategies, for example, legislation, soft law instruments, extended consumer

responsibility and stewardship approaches – cannot be classified as either antecedent or consequence strategies and straddle the divide, acting on a continuum by providing incentives for prevention and penalties for littering behaviour. In addition, a literature review of anti-littering strategies in Indonesia (Dhahir 2020) indicates that stakeholders should collaborate, that policies should be integrated, that combined problem solving should take place and that quick responses to littering are needed as well as sustained advocacy. These complex approaches also do not easily fit into such a taxonomy.

3.6.2 Antecedent strategies

3.6.2.1 Engineering or design procedures

Littering may be addressed with a range of infrastructural measures. Preventative infrastructure may function as a management measure to guide public disposal behaviour. Importantly, infrastructure should be convenient, available, sufficient and accessible (Almosa et al. 2020). Examples may include litter bins or explanatory panels at strategic points such as entrances, viewpoints, picnic areas or other recreation areas (Rodríguez-Rodríguez 2012; Willis et al. 2017; Almosa et al. 2020). Measures need not be complicated and relatively simple adaptations to infrastructure, such as providing litter cans, are perceived to decrease littering, or installing litter traps on stormwater drains. A study on marine litter in Tasmania, Australia and feedback by interviewees in a study conducted in the Nablus district, West Bank, Palestinian Territory, indicated that the availability of litter cans was one of the main factors that can reduce littering (Al-Khatib et al. 2009; Willis et al. 2017;). However, receptacles should be fit for purpose and accessible, as suggested in a study in Lambeth, central London where cigarette butt littering could be countered more effectively with litter bins with large ashtrays that are easy to use, have stubber plates that are clearly visible and two compartments for waste and recycling (Bonarrigo et al. 2020). Receptacles that are portable and which therefore reduce the private costs (time and inconvenience) of cigarette butt disposal decreased littering by 10–12% on the beaches of the north-east coast of Italy, where the intervention was staged (Castaldi et al. 2021).

Design procedures can also involve the use of stimulus control techniques in natural settings where the cost and logistical problems in the distribution of reinforcers are obstacles (O'Neill et al. 1980). Earlier work by, for example, Finnie (1973, cited in O'Neill

et al 1980) tested the effect of the presence of litter receptacles on highways and investigated the effect of bins with attractive advertising compared to 55-gallon drums (O'Neill et al. 1980). O'Neill et al. (1980) also compared the effect of bins with a higher degree of stimulus control (designed to attract attention when litter is deposited by automatically tipping a hat) to conventional trash receptacles in an area associated with high litter rates and generally not provided with litter receptacles. Containers designed to provide stimulus control attract more litter than typical litter receptacles.

3.6.2.2 Prompts

3.6.2.2.1 Psychology of surveillance

Some studies on the psychology of surveillance have indicated that images of watching eyes induce more prosocial behaviour. Research has also been conducted in the context of littering. People are, for instance, less likely to leave litter on cafeteria tables in self-clearing areas if images of watching eyes are displayed (Ernest-Jones et al. 2011). However, this is not a consistent finding. One study conducted at bus stops in Geneva with separate litter bins for paper and plastic indicated that watching eyes may not be a sufficient cue to trigger the clearing of litter. However, where individuals did pick up litter, they invested more time in clearing up garbage in the presence of watching eye images (Francey and Bergmüller 2012). Images of watching eyes at bicycle racks near the entrance of major university buildings with a litter receptacle in the vicinity do not make behaviour more normative, but do encourage more pro-social behaviour independent of the local descriptive norm (Bateson et al. 2013). In a further experiment, the hypothesis was tested to ascertain whether the transfer of watching eye images onto potential items of litter would decrease littering. Items with images of watching were less likely to be littered and people were less likely to litter in the presence of other people in the vicinity. This experiment suggests that cues of observation on packaging could reduce littering and that accompanying explicitly verbal messages about littering are not necessary (Bateson et al. 2015).

3.6.2.2.2 Sensory stimulation

Evidence from a scent manipulation experiment in a natural setting on Dutch trains seems to support the theory that cleaner scent can be used to counteract littering behaviour and, more generally, that the cognitive route of scents to manipulate behaviour can be a tool

for behavioural change (De Lange et al. 2012). Sensory stimulation in terms of visual communications designs in an anti-littering campaign built on pre-existing habits of mountain climbers to use social media platforms like WhatsApp, Instagram, YouTube, Line and Facebook. Key visuals were used to raise awareness of the consequences of littering on the mountains, e.g. the danger to animals, through YouTube banner ads, Instagram posts and pop-up banners on a website in a study conducted in nature parks in Mount Gede Pangrango National Park, West Java, Indonesia (Chandra et al. 2021).

3.6.2.2.3 Green nudges

Thaler and Sunstein (2008: 6) have defined a nudge as “any aspect of the choice architecture that alters people’s behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates”. Schubert (2017: 330) notes that the premise of effective nudges is that they are “only effective in a behavioural world, where individuals exhibit limited mental resources, i.e. limited rationality, attention, and willpower, and where preferences are often not ‘given’ but rather ‘constructed’”. Nudges contrast with traditional policy tools because the latter affect behavioural change with mandates, bans or economic incentives. Ideally, nudges utilise and respond to the cognitive biases of people in a transparent way but without removing option sets or changing monetary incentive structures (Schubert 2017). The adoption of behavioural modification techniques, originating in behavioural sciences, is increasing. In comparison to traditional policy tools like taxes or other financial incentives, nudge interventions seem to be viewed in a favourable light (Benartzi et al. 2017). Nudges may potentially complement traditional regulation that is information and incentive centred and increase their effectiveness and popularity among the general public (Schubert 2017). Green nudges aim to encourage environmentally beneficial behaviour, in particular to contribute voluntarily to environmental protection (Schubert 2017). Schubert discusses three analytical categories of green nudges, of which two seem to be applicable to nudging in a littering context. Firstly, green nudges harness consumers’ desire to maintain a positive self-image through pro-environmental behaviour and appeals to their social identity. An example is the “Don’t mess with Texas’ social advertising campaign which started in 1986 and appealed to the sense of community pride of Texans. The campaign depicted littering as behaviour which Texans would find aversive. With an estimated litter

reduction of 70% between 1986 and 1990, the campaign has been one of the most successful green nudges to reduce littering on highways (Schubert 2017). Secondly, green nudges capitalise on people's tendency to imitate the behaviour of their peers. An example would be to convey social norms through peer comparison and stimulating social status competition.

Examples of green nudge interventions to curb littering have been conducted in Copenhagen to encourage more effective use of street litter bins by painting footprints on the ground leading up to the bins and wrapping the bins in a bright colour. During an experiment designed to test the effect of the nudge, free sweets were distributed before and after the nudge. A significant decrease was reported in wrapper litter after the nudge (see iNudgeyou). This anti-littering nudge intervention has been replicated in Scotland. Initial findings indicate support for the research proposition that littering is affected by the intervention (Zero Waste Scotland "Nudge Study – Promoting the Use of Litter Bins" available at <https://www.zerowastescotland.org.uk/litter-flytipping/nudge-study>; Keep Scotland Beautiful and Institute for Social Marketing, University of Sterling *Report Nudge Study Implementation Toolkit: Promoting the Use of Street Litter Bins* (2015) available at <http://inudgeyou.com/green-nudge-nudging-litter-into-the-bin>). Another example of the use of social nudges can be drawn from a US campaign. In an argument to defend the use of social nudges against moral objections of lack of coherence and autonomy, Nagatsu (2015) also discussed the use of social nudges in the "Don't Mess with Texas" campaign. This campaign combined elements of nudges and more traditional regulations.

3.6.2.3 Verbal messages

3.6.2.3.1 Affective appeal or factual presentation

Horsley (1988, cited in Hansmann et al 2009) studied the effects of differently phrased anti-littering signs and concluded that the style of the message is important. Ambiguously worded signs did not encourage an anti-littering attitude, whereas positively worded signs are more effective. In a Swiss experiment testing messages promoting battery recycling, the humorous slogans did not perform better than factual slogans in encouraging customers to return used batteries (Hansmann et al. 2009). The effectiveness of the factual slogan was explained with reference to reactance theory, which accounts for the processes that undermine communication of social norms. According to the theory,

people want to determine their own personal norms, decisions and actions, and exhibit active or passive resistance to social pressures that undermine their behavioural freedom and self-determination. Thus the humorous slogan could be perceived as prescriptive and as restricting the behavioural freedom of customers. The factual slogan did not produce reactance because it did not urge people to perform a certain action. It seems that informing customers about a social norm in a descriptive manner has a stronger influence than demanding that they comply with the norm. Moreover, factual slogans may also bypass the generation of justifications for non-recycling.

Other appeals to affect involve the identifiable victim effect (Perrault et al. 2015). People seem to be more willing to help identified individuals than unidentified ones. Messages containing accounts of identifiable victims are more vivid and evoke empathy, altruism and even distress. In contrast to appeals involving unidentified victims, receivers cannot fall back on statistical percentages and the consequences of action or a lack of action are more salient. Earlier studies tested whether people were more willing to contribute money to a cause promoted by an identifiable victim message. However, people can also donate time by, for example, volunteering to clean up litter. Perrault et al. (2015) compared the effect of using humans and animal as identifiable victims in anti-littering messages and concluded that although the identified animal message evoked more empathy and distress compared to messages with identified humans, messages were equally effective at generating volunteer activity and perceived future littering behaviour. However, no-victim control messages fared just as well as the animal messages. Engendering empathy or affect may therefore not necessarily be more effective in inducing anti-littering behaviour.

Drawing on the sense of belonging to a particular community could also enhance anti-littering messages alerting the public to monetary penalties imposed for littering behaviour (Bonarrigo et al. 2020).

3.6.2.3.2 Persuasive communication

The purpose of persuasive strategies, as a tool in environmental education, is to convey the justification for norms without threatening or sanctioning the audience for non-compliance. In this sense, awareness of the environmental issue is enhanced and the

platform is created for a positive disposition facilitating adequate behaviour. Morgan et al. (2021), for instance, found that smokers who received anti-littering messages had higher intentions not to litter than those who received chemical messages. They had more knowledge about the prevalence of cigarette filters as the most common litter type, had more conversations about not littering and thought more carefully about proper disposal. Persuasive messages may be communicated through different media – e.g. through personalised verbal requests, signs and brochures (Cingolani 2016).

Recent research on persuasive strategies highlighted the importance of social normative information, i.e. the “innate rules guiding individual and group behaviour and thought in the social sphere – to shape social behaviour” (Hassell and Wyler 2019: 232). Perceptions about social norms shape beliefs about appropriate actions and influence behaviours (Hassell and Wyler 2019). A study conducted in Saudi Arabia confirmed that individuals often behave consistently with their values and beliefs, and this study showed litter prevention and proper disposal were consistent with Middle Eastern religious values (Almosa et al. 2020).

The efficiency of persuasive strategies also depends on the presence of aligned normative information. Descriptive norms pertain to behaviours which are typically performed, while injunctive norms involve perceptions about which behaviours are generally approved or disapproved, and the social punishments or awards that accompany conformity to the norm (Cialdini 2003; Hassell and Wyler 2019). Although research indicates that both types of norms act as motivation for human action, some research indicates that persuasive communications are most effective when descriptive and injunctive messages are aligned and work together. That is, persuasive messages would not be as successful if they reveal that offences against the environment are frequent and typically carried out, while simultaneously appealing to pro-environmental behaviour. However, when pro-environmental behaviour is the norm, an injunctive norm signalling pro-environmental behaviour will be more effective (Cialdini 2003; Almosa et al. 2020). Recently however, scholars have cautioned against sweeping conclusions about the power of positive and negative descriptive norms, in particular where political behaviour, e.g. signing petitions, is concerned. Earlier research conclusions that negative descriptive norms are ineffective, might be overstated. Negative descriptive social

normative messages may generate higher anger levels compared to positive social descriptive norms and lead to an emotional response that encourages purposive political activity. Furthermore, individual reactions also depend on recipients' propensity for action, the objectives of the appeals and their benefits. Negative descriptive norms are more effective in motivating the general public to engage in activist behaviour, but where individuals already identify as activists, normative frames have less effect in shaping behaviour (Hassell and Wyler 2019). To summarise, where the goal of persuasive communication is to prompt political participation in influencing environmental policy, negative descriptive norms might have a positive impact where the audience do not identify as activists.

3.6.2.3.3 Face-to-face communication

A Swiss study on the effect of personal, problem-centred face-to-face conversations in anti-littering campaigns indicates that this communication strategy is effective in raising awareness about littering and may lead to positive behaviour. The study is based on perceptions of participants and not on observations of actual behaviour following the intervention (Hansmann and Steimer 2015). This strategy provides opportunities to probe habits and underlying belief systems in a flexible way, to present arguments promoting insights, positive attitudes and opinion changes. It even allowed respondents to express a commitment to anti-littering behaviour.

A study by Fernandez-Haddad et al. (2021) investigated the role of community health workers (*promotoras*) to identify and involve stakeholders in environmental cleaning during two community interventions in Mexico and Arizona. These interventions were based on community-based social marketing, focusing on strategies that highlight personal community-level connection to enable behaviour modification by increasing the visibility of desired behaviour by exposure to it or encouraging campaigns. Community members are empowered to play a leading role in the change. In the relevant interventions *promotoras* engaged communities to address the problem of littering. In the Mexican intervention *promotoras* contacted the communities through visits or house-to-house co-responsibility workshops to increase awareness of clean cities and their benefits through teaching materials, and incentivised interactive games and activities. This increased community motivation and participation.

3.6.2.4 Demonstrative messages

The aim of demonstrative messages, as a strategy in environmental education, is to show how most people behave in a particular environment. Demonstrative messages range on a continuum from weak signals, e.g. maintaining a clean setting, to stronger signals such as visually demonstrating picking up litter. This type of communication is based on the premise that people tend to imitate behaviour (Cingolani et al. 2016). In this regard, the literature indicates that people are less likely to litter when observing someone picking up debris ((Beeharry et al. 2017).

A social media group established in India, named *The Ugly Indian (TUI)* aims to change the attitude that links public filth to identity (Luthra 2018). The online community relies on social media, and in particular on Facebook and Twitter, to disseminate their message and recruit volunteers. The volunteers are added to a database and invited to planned spotfixes. They organise clean-up activities, or spotfixes, to deal with problematic public spaces by cleaning up the site, fixing broken sidewalks, removing posters and repainting walls. *TUI* also uses its Facebook page to feature the work of organisations inspired by their initiative. Spotfixing can be described as a local activity, since volunteers conduct it in or near areas where they work. It seems that apart from these spaces, sites frequented by the upwardly mobile classes feature prominently. Luthra (2018) cautions that although such volunteering efforts may be commendable, they reveal ideological bases with particular structural and historical biases and privilege a certain aesthetic, which might be at the expense of practical efficacy.

Community clean-up days were also recommended in a study conducted in Lambeth, London (Bonarrigo et al. 2020) to increase awareness about littering and to contribute to a clean environment by decreasing the likelihood of littering. The authors also suggested that local businesses collaborate with local governments to enable funding for these types of events (Bonarrigo et al. 2020).

An important caveat in terms of clean-ups as a demonstrative message is that they can cause ecological disturbances when mechanical activities such as, for example, beach raking is involved. Moreover, in the case of litter that not only originates from

anthropogenic activities (i.e. items that were discarded, abandoned or abandoned by people) directly, for example beach litter, regular clean-ups still fail to deal with about half of the accumulated waste (Watts et al. 2017).

3.6.2.5 Awareness and education strategies

One of the essential components in preventing pollution in general and affecting attitudinal change is raising public awareness. In fact, Storrier and McGlashan (2006: 193), in the context of marine litter, view this strategy as the “only guaranteed way of reducing the amount of marine litter on beaches”. The role of awareness of litter has also been emphasised by Roper and Parker (2008) in a marketing study conducted with UK respondents including students and employees of a not-for-profit charity known for environmental campaigns. These authors demonstrated that a high percentage of customers cannot recall seeing litter on an image of an urban scene containing litter in a recall exercise. Consequently, campaigns aimed at socialising customers against littering may be ineffective, since customers may be nonresponsive to the message. Roper and Parker (2008) argue that advertising campaigns should rather raise awareness of the occurrence of litter. Akpoghiran (2020), in a study in Nigeria, also stated that the use of media advocacy to discourage littering should be consistent..

Some research indicates that environmental knowledge plays only a small part in pro-environmental behaviour and does not in itself seem to be a prerequisite for pro-environmental behaviour. Educational endeavours should instead take account of the role of environmental value as an intervening variable between environmental knowledge and pro-environmental behaviour. Environmental value is based on experiences. Therefore, experiences should be crafted to foster pro-environmental behaviour (Latif et al. 2013). Hartley et al. (2015) demonstrated that an educational intervention in the UK not only increases the environmental concerns of children about marine litter, but also increases the self-reported actions to reduce the causes of marine litter. The educational intervention consisted of posters, artwork, demonstrations and mini-experiments. Moreover, the intervention also included exposure to mitigative and preventive actions. Children also challenged their family and friends to engage in litter-reducing behaviours after the educational intervention. Therefore, the research suggests that educational interventions may impact on communities on a wider scale and may be self-reinforcing.

The use of educational efforts can also be motivated by identifying the origin of litter at a specific site. In a study on marine litter in the Arab-Israeli town of Jisr, Portman and Brennan (2017), with reference to Pasternak et al. (2017), note that when beach litter originates from land-based sources, the focus should be on educational efforts, and sometimes advocacy. However, since education is a long-term solution, it may not be viable to elicit proactive behaviour among beachgoers and hence short-term measures for beach litter reduction should also be considered. Both long- and short-term measures should take into account the local context and social norms such as the acceptability of littering in public spaces and the composition of litter (Portman and Brennan 2017).

Incorporating experiential and service learning seems to have not only a short-term effect by increasing awareness of environmental issues, augmenting environmental perceptions and consciousness, but also resulted in environmentally responsible behaviours. Retention of pro-environmental attitudes and behaviours and the added benefit of intergenerational learning are retained at least two years after environmental service learning (Schneller 2008). Bonarrigo et al. (2020) also recommended that education of young people be accompanied with knowledge application by, for instance, creating anti-littering posters or assisting other peers to paint litter bins for the local government. Experiential learning about the environment in middle school contexts seems to produce long-term pro-environmental attitudes as indicated by a study conducted in Baja California Sur, Mexico (Schneller 2008).

In a study by Matsekoleng (2021) in Thokoza Township, Ekurhuleni East, Johannesburg, South Africa, progressive environmental action research activities involving action research cycles (establishing a vegetable garden, yard cleaning, composting, planting flowers and crocheting) were used to encourage children as co-researchers to be involved mentally, emotionally and physically and to raise their awareness of littering as well as to promote a positive attitude.

A study conducted at Tasmanian beaches indicates that a large percentage of participants do not litter at beaches (Slavin et al. 2012). The author suggests that this might point to a strong social norm to keep beaches clean. Slavin (2012) associates social

norms with demographic factors (e.g. age) and suggests that anti-littering education can be adjusted to address potential litterers by taking account of the demographic factors that influence their behaviour (Slavin et al. 2012).

The cost of preventative approaches to littering (e.g. educational briefings and material) may require substantial resources – also in terms of educational staff. However, in the long term an educational approach may be profitable compared to reactive approaches like cleaning patrols. Educational interventions may also be necessary to prepare people for the implementation of other strategies like a trash-in/trash-out scheme (Rodríguez-Rodríguez 2012).

3.6.3 Consequence strategies

3.6.3.1 Strategies to internalise externalities of littering through penalties

Support for the notion that strategies that internalise the private cost of littering by instituting a penalty will decrease littering was demonstrated in a controlled laboratory experiment among undergraduate students in Islamabad. Fines may therefore lead to less frequent littering. Where fines are not an option, the negative externality (i.e. the uncompensated environmental effects with an impact on consumer utility and enterprise cost outside the market mechanism) of littering can be limited by informal institutions such as social norms and peer effect (Khawaja and Shah 2013).

3.6.4 Hybrid strategies

3.6.4.1 Legislation and policy

Although attempts to enforce existing anti-littering laws have been made, they are not generally diligently enforced in most jurisdictions and regulatory efforts do not have a significant impact, for example, where the littering of cigarette butts is concerned (Barnes 2011; Stigler-Granados et al. 2019). Hinčica (2018) also confirmed that increased fines or other forms of punishment may not always lead to decreased littering, for example, where convictions do not regularly take place.

Nevertheless, several studies recommend environmental policy reviews as a measure to address littering (see, for example, Awunor et al. 2021). Some authors state that international agreements cannot address the issue of marine litter along with its economic and social consequences in isolation, but need to be combined with action by various

sectors of society such as launching initiatives to raise ecological awareness by means of education (Aretoulaki et al. 2021). In a study by Mohajerani et al. (2020) the authors also recommended that in Australian cities strict prohibition of littering and severe fines should be supported by other strategies such as education, guidelines and advertising as well as adequate waste infrastructure at strategic points.

3.6.4.2 Extended consumer responsibility and product stewardship approaches

Abatement fees serve as economic disincentives, support public education campaigns to reduce litter and recoup city clean-up costs. They have, however, been challenged by litigation brought by affected industries, e.g. the tobacco industry (Barnes 2011).

Extended producer responsibility places the responsibility for waste management for end-of-life products on the manufacturer. Initially, extended producer responsibility was implemented in Europe in the 1990s and was integrated into EU environmental policy in 2002. The singular regulatory scheme has, however, led to challenges as it applies to an extremely wide range of products. In the USA states have enacted EPR laws since 2010, applying to specific products (Barnes 2011).

The aim of product stewardship models is to bring about a shift in the responsibility for and costs of environmental protection. In these models responsibility for the product mainly rests with the manufacturer, retailer and consumer instead of the taxpayer. Compared to extended producer responsibility, product stewardship therefore adds retailers and consumers as stakeholders into the process. Responsibility increases with the ability to influence the lifecycle of a product. These models originated in the USA and have gained global traction – see, for instance, the comprehensive product stewardship law proposed in 2011 (Barnes 2011).

3.6.4.3 Multipronged campaigns

Several studies indicate that multipronged approaches are effective strategies to deal with litter. Although specific strategies like beach clean-ups can change short-term behaviour, long-term behavioural change requires coordinated operations that involve various communities and improvement to waste management systems. Particular strategies might, for example, include publicity, education and legislation (Storrier and

McGlashan 2006). In Britain a Coastal Litter Campaign was based on various methods of information distribution such as a travelling exhibition with posters and leaflets provided to organisations in the vicinity of a targeted area such as libraries, leisure centres and community centres and to visitor attractions. In addition, schools and communities were provided with access to talks, desk-based activities and field visits. In addition, communities and organisations were encouraged and adopted their own clean-up events. To increase visibility this initiative was scheduled in association with an Adopt-a-Beach campaign. The campaign was also endorsed and supported by local authorities. This broad involvement is conducive to a “nonfragmented approach” (Storrier and McGlashan 2006: 190) and is viewed as a key component of a successful integrated approach. The campaign also promoted its anti-littering agenda at different publicity events as well as through education and legislation (Storrier and McGlashan 2006). Another European initiative that highlighted the importance of a multi-pronged approach in addressing the issue of marine litter, the Marine Litter in Europe’s Seas: Social Awareness and Co-responsibility (MARLISCO) project, raised awareness and promoted engagement through public exhibitions, a video competition aimed at students, provision of educational and decision-supporting tools and national participatory events to facilitate dialogue on solutions. These activities proved to be effective in improving perceptions of the impact of marine litter and enhancing commitment waste management activities e.g. separation for recycling and reduction of packaging use (Veiga et al. 2016). In Malaysia the conventional cleanliness campaigns were replaced by an Anti-litterbugs Campaign. The campaign was launched and implemented in 2008. The previous cleanliness campaign aimed to create cleanliness awareness among residents through *gotong royong*, a concept that can be defined as reciprocity or mutual aid, involving the clean-up of a littered site and the distribution of free t-shirts, caps, and light food and drinks to participants. Billboards with ambiguous messages are also used. Targeted areas deteriorated in a short time. The failure of this approach may be related to the lack of comprehensive community participation. Moreover, these cleaning campaigns are costly, do not educate the participants on how to properly dispose of litter, fail to create awareness of the negative effect of littering and do not aim to end public littering nor stress enforcement of by-laws against littering. The cleanliness campaigns also fail to respond to people who litter and instead focus on the litter itself and they do not use multiple strategies (e.g. education, enforcement, infrastructure and public participation) to address the problem of

littering (Hing and Gunggut 2012). The Anti-litterbugs Campaign is described as a more clearly targeted, integrated and systematic approach, providing infrastructural support (e.g. rubbish bins) and combining an awareness campaign and enforcement. Moreover, it encourages continuous communication about the campaign. It consists of 17 components, namely the creation of litter-free premises, presenting litter-free events, announcements from various platforms such as moving vehicles, shopping complexes and through air travel announcements, displaying banners and streamers with simple anti-littering messages, presenting a road show, exhibitions and talks on the campaign, encouraging table talk, community reporting of littering from vehicles, distributing pocket ashtrays, sending an open letter to smokers, organising a *gotong royong* to fine litterbugs, appointing an anti-litter ambassador, publicising the campaign in the newspaper, arranging additional duties for security guards, ensuring continuous enforcement, exhibiting before and after pictures, distributing dustbins and weighing rubbish. The campaign appears to have been successful in terms of reducing litter. Prior to the campaign the amount of rubbish collected by the Kota Kinabalu City Hall was weighed and recorded. After implementation the amount of rubbish had been reduced by 50%. Subsequently, variations in implementation progress were noted and explained through the concept of campaign internalisation among local authority leadership in nine of the 25 local authorities in Sabah, Malaysia where it was implemented (Gunggut et al. 2013). Gunggut et al. (2013) found that internalisation is reflected in understanding of the campaign and the priority given to it by local governments as perceived from their actions, choice of words and activities. Top leadership demonstrating internalisation through progress in the implementation of the campaign.

Support for the effectiveness of multipronged campaigns was also evident from a Swiss experiment combining face-to-face conversations and anti-littering posters (Hansmann and Steimer 2015).

In India, the *Swachh Bharat* campaign, a five-year-long nation-wide cleanliness project, focused on anti-littering and volunteer clean-up activities but nevertheless with a much broader scope, funding the building of toilets, solid-waste management systems and information, education and communication campaigns to create awareness and change behaviour (Luthra 2018). The awareness campaigns were conducted over radio, social

media, documentaries, plays and workshops, and aimed at fostering a spirit of volunteerism and civic duty with respect to public hygiene. In particular, the campaign relied on social media to bolster public support. Social media were utilized to issue clean-up challenges which involved the cleaning up of public space and the posting of 'before and after' pictures. The website recorded active participants, challenges taken, activities done and hours contributed (Luthra 2018).

4. Chapter 4: Irregular dumping

4.1 Introduction

Irregular dumping can be defined as the intentional and criminal abandonment of waste without a licence on unauthorised sites instead of disposing of waste at an authorised rubbish dump or landfill site (Liu et al. 2017; Lu 2019). Muzenda et al. (2019) distinguish between littering and illegal dumping based on the quantity disposed – the latter concerns larger quantities of waste. Du et al. (2021) make the important point that illegal dumping is framed differently depending on the research discipline involved. Conceptual framing, for example, ranges from regarding the practice as environmental pollution (environmental science and ecotoxicology) to cost-related decision-making (economics). Research topics are also discipline-specific, e.g. in management research the causes are studied, while in technological research prediction of future dumping sites is an important objective (Du et al. 2021).

Irregular dumping and waste trafficking have a significant impact on the dilemma of dealing with global waste (D'Amato et al. 2018) and remain worldwide problems (Jakiel et al. 2019). In fact, Almer and Goeschl (2015) note that irregularly disposed waste represents the largest share of environmental crime, is more persistent and has a spatially more concentrated impact compared to other environmental crimes. Countries with frequently reported incidents of irregular dumping include Australia, Italy, Spain, Israel, Mainland China and Hong Kong (Lu 2019), and Slovakia (Šedová 2016). It seems that the problem is pervasive in countries with rapid GDP growth (Lu 2019).

The practice of irregular dumping, also known as fly dumping or fly tipping, has an impact on the economy and tourism (Jakiel et al. 2019), encourages economic fraud (Navarro et al. 2016), increases clean-up costs (Matsumoto and Takeuchi 2011), causes environmental damage and risk to the underlying soil quality and watercourse (Šedová 2016; Liu et al. 2017; Jakiel et al. 2019, Lu 2019), raises human health concerns (Matsumoto and Takeuchi 2011; Navarro et al. 2016; Lu 2019; Narduzzi et al. 2020; Cham et al. 2021) as well as animal health implications (Ferrante et al. 2020), results in habitat destruction, wildlife deaths, promotes the spread of invasive species and leads to aesthetic damage to the landscape (Matsumoto and Takeuchi 2011; Navarro et al. 2016; Šedová 2016; Jakiel et al. 2019; Lu 2019). Otwong et al. (2021), in a study in Thailand

on legal obstacles for the circular economy where illegal dumping of recyclable hazardous industrial waste is concerned, also highlighted that illegal dumping impacts on circular economy development by leading to the loss of valuable resources, compromising the value of the biological cycles of the circular economy and resulting in the rejection by the public of recycling facilities (both current and future).

Situ (1998) observed that research on environmental crimes such as irregular dumping, discharging, generating, storing and transporting regulated or hazardous waste by the general population was still inadequate. This type of research only started to emerge towards the end of the twentieth century. This may explain why research on criminal activities in the waste management system is still relatively scarce (Matsumoto and Takeuchi 2011; D'Amato et al. 2015). There also seems to be a dearth of empirical studies on irregular dumping. Studies on irregular dumping have been conducted in various world regions including Western Europe, Central Europe, Asia, North America and Australia but remain limited. The dearth of research is linked to a lack of data, low data quality and problems with data accessibility and consequently the extent of the problem is underestimated (Jakiel et al. 2019). Previous studies investigated irregular dumping in terms of legal responses, stakeholder decision-making behaviour, related factors, and physical and ecological impacts (Du et al. 2021). Some examples include research on the dumping of used oil in the USA (highlighting that the practice was related to restrictions on the disposal of used oil), the relation between the introduction of unit pricing of municipal solid waste in Korea and irregular dumping, the impact of a shortage of waste treatment facilities on the frequency of irregular dumping in Japan (Ichinose and Yamamoto 2011) and the socio-economic, structural and legal drivers of irregular dumping in England.

Studies on illegal dumping have also been conducted in developing countries. Examples within the African context include Nigeria (Nwafor et al. 2019; Oleabhiele and Dotimi 2020; Sunday and Babjide I 2020; Umar and Aondowase 2021), Ghana (Kodua and Anaman 2020) and South Africa (Muzenda et al. 2019; Niyobuhungiro and Schenck 2020; Dladla et al. 2021; Niyobuhungiro and Schenck 2021). Compared to studies on littering, there is even less literature on illegal dumping in South Africa.

Du et al. (2021) have identified potential research directions for future research on irregular dumping. Within the social and economic sciences, future research could potentially concentrate on the improvement of the stakeholder-decision analysis model and research on the scope of stakeholders in illegal dumping as well as the development of a unified evaluation standard for ascertaining costs of illegal dumping. In addition, the evaluation of the interaction effects of various determinants could be improved, the effects of these factors can be compared, and other determinants can be investigated. Technological research could analyse the practice with a combination of big data and data on solid waste quantities and these results could also be combined with monitoring in the analysis of the dumping of household waste. Within the context of environmental science and ecotoxicology, the migration of pollutants in the food chain could be studied as well as targeted treatments of dumped pollutants (Du et al. 2021).

4.2 Causes and predictors of irregular dumping

Both theoretical and empirical research have highlighted potential factors that lead to irregular dumping. In a synthesising literature review Niyobuhungiro and Schenck (2020) distinguished three categories of drivers of indiscriminate dumping, namely inadequate waste management services, a lack of knowledge and awareness, and social dis/organisation. This is echoed in research conducted in Malaysia by Rahim et al. (2021) indicating that significant determinants but also challenges in relation to construction waste include awareness, facilities and technology. In particular, the authors found lack of awareness to be the most significant factor (Rahim et al. 2021). In an earlier study by Brandt (2017) on illegal dumping, lack of awareness of urban waste management options and disorganisation were also related to illegal dumping. Moreover, the practice was portrayed as a visual indicator of social disorganisation in neighbourhoods. Similarly, Umar and Aondowase (2021), in a study in urban Nigeria, found that apart from inadequate waste disposal facilities, low environmental awareness leads to irregular dumping. The authors added two other reasons, namely, a lack of effective law enforcement, and insufficient planning (Umar and Aondowase 2021). Indiscriminate dumping was also related to inadequate law enforcement and a lack of awareness, but the authors also indicated that a lack of waste segregation space and family and individual behaviours were some of the key factors in the Gambia contributing to indiscriminate dumping (Kuyateh and Cham 2019). Viewing indiscriminate dumping as a long-standing

family practice, or legacy dumping, was also confirmed as one of the reasons by Culver et al. (2019). According to Liu et al. (2017), reasons include the shortage of proper waste treatment facilities, weak landfill regulations, high tax rate, weak enforcement power when waste regulations are violated, asymmetries of regulations between nations, the price of legitimate dumping, the global market of waste trading and organised waste crime. Lu (2019) also mentions the avoidance of tipping fees and saving transport time and costs as well as convenience as a reason for irregular dumping. Convenience was also listed as a reason for dumping by Culver et al. (2019).

Theoretical research that explains irregular dumping behaviour from an economic point of view can be traced back to Becker's economic model of non-compliance developed in 1968 (Sotamenou et al. 2019). According to the model, a rational agent makes the decision to comply with the legal requirements for an action by comparing the costs of compliance (determined by effort and resources needed to perform the action) with the expected costs of non-compliance (determined by the expected monetary sanction). Other determinants of the cost of non-compliance were subsequently added to account for non-monetary, remedial and social sanctions (Sotamenou et al. 2019). Following from these theoretical positions, the fields of public law enforcement and environmental economics ascribe noncompliance and irregular environmental behaviour to the perceived possibility of saving on compliance costs (e.g. avoidance of tax payments on legal disposal) and strategic behaviour related to the expected punishment for non-compliance (i.e. choosing to perform an irregular activity based on the probability of detection and the severity of penalties). If the tax payment for legal disposal increases, firms, individuals and households will be motivated to practise irregular waste management behaviour. When monitoring of behaviour is increased, the probability of the detection of irregular behaviour is increased and an increase in expected fines can be anticipated. Since the cost of the violation is increased, stricter enforcement may lead to more compliance. Some studies in Germany and Japan provide support for this deterrence theory, although a UK study did not find that law enforcement had a significant impact. Strictness of government enforcement of environmental controls is an important factor: public monitoring and sanctions, inadequate resources or inadequate penalties may be related to an increase in irregular waste practices. Deterrence is linked to a sufficiently large number of inspections and even if crimes do not decrease, they can still

increase at a decreasing rate (D'Amato et al. 2018). Culver et al. (2019) also related indiscriminate dumping to cost avoidance.

Social factors influencing irregular dumping include decreased public order and management level (Yang et al. 2019). Where public order and management level decreases, disorder of spatial features increases and attracts criminal behaviour including indiscriminate dumping. With lower levels of community management, enforcement of legislation is weaker as well. Wright et al. (2018) also note social factors linked to public space dumping, namely population density, percentage of renters in an area, unemployment and income. In terms of demographic and socio-economic factors associated with irregular dumping, Joo and Kwon (2015), with reference to Hollander et al. (2009), summarise factors that impact on irregular dumping of household garbage, namely population decline, lower education level and the unemployment rate. In developing countries education, family size and available income are relevant determinants (Sotamenou et al. 2019). In a study conducted in Hong Kong, China, Chu (2021) identified intrinsic neutralisation (e.g. denial of responsibility, denial of injury, and defence of necessity) and gender as significant factors related to the intention to dump waste illegally. In this study females were more likely not to dump waste than males were (Chu 2021). A South African study conducted in West Rand District Municipalities also characterised areas where illegal dumping is more prevalent: they show increased waste generation, high population density, and low-income households and informal settlements (Muzenda et al. 2019).

Communities in Japan with high unemployment rates show a higher frequency of irregular dumping. These results are tied to an increase in disposal costs and a decline in the ability to enforce waste regulations (Matsumoto and Takeuchi 2011). In terms of the effect of income level on irregular dumping, results differ. Liu et al. (2017) found that a higher income level correlates with decreased irregular dumping in England. Residents in higher-income areas can afford and use more environmentally friendly but expensive products, and can afford more expensive services by government licensed waste treatment companies. Sotamenou et al. (2019) and Tadesse et al. (2008) also confirmed that high-income respondents in Yaoundé, Cameroon and Mekelle city, Northern Ethiopia are less likely to practise irregular dumping. However, Matsumoto and Takeuchi (2011) found

that the growth of irregular dumping is higher in high-income communities in Japan.

Structural issues such as insufficient public garbage collection services and facilities are determinants of irregular dumping (Joo and Kwon 2015; Umar and Aondowase 2021). One of the structural causes of irregular dumping is a shortage of waste facilities and waste treatment facilities. The cost of waste disposal increases where sufficient proper waste treatment facilities are absent. Consequently the likelihood of irregular waste disposal increases to reduce the cost of disposal (Tadesse et al. 2008; Joo and Kwon 2015). In particular, the number of intermediate waste treatment facilities where waste incineration or weight reduction occurs, before disposal in landfill, is related to irregular dumping (Joo and Kwon 2015). Ichinose and Yamamoto (2011), focusing on irregular dumping of industrial waste in Japan, found that increasing the number of intermediate waste treatment facilities decreased the frequency of irregular dumping. They also note that there is a positive relationship between the weight of waste discharge and the number of irregular dumping incidents. In addition, they concluded that stronger penalties for irregular dumping deter irregular dumping. They could not, however, draw a clear conclusion about the relation between the number of landfill sites and the frequency of irregular dumping incidents. In addition Liu et al. (2017) found that a decrease in landfill capability is related to the increased incidence of irregular dumping. In addition the dispersion of landfills is positively and statistically related to irregular dumping. If it is difficult to find landfills in an urban area and to landfill, irregular dumping will increase. A matter that complicates the supply of waste facilities is the effect of the NIMBY attitude. If households reject the placement of waste containers near their homes or anywhere in the city, they will opt for disposal in open areas and valleys (Tadesse et al. 2008; Joo and Kwon 2015).

Šedová (2016) recognises that irregular dumping has a spatial dimension. A socio-spatial factor is unclear ownership, which is tied to an increase in dumping of household garbage. In addition, physical characteristics of dumping sites such as disorder or lack of care, lack of aesthetic appeal and evidence of previous dumping is correlated with irregular dumping (Joo and Kwon 2015; Wright et al. 2018). Population density also has spatial impacts. Where areas are occupied with fewer residents, the probability of detection is lower (Almer and Goeschl 2015, with reference to Eckert 2004; Wright et al. 2018). Conversely,

in locations with a high flow of people indiscriminate dumping decreased (Yang et al. 2019). This is due to regulations and social norms which present greater barriers to illegal dumping in areas with high visibility (Yang et al. 2019). The influence of site-specific characteristics (e.g. lower levels of occupation, accessibility through extended opening times and the presence of gates or fencing) on irregular dumping has also been confirmed in a study on irregular dumping at charitable collection points in Perth, Australia (Wright et al. 2018). Other spatial factors that increase the likelihood of irregular dumping include road proximity, covert location, land use and the proximity to legal waste management facilities (Jakiel et al. 2019). Characteristics of land with mixed residential and commercial use include aspects such as lack of occupation, lower visibility (because of lack of traffic and lighting) and familiarity of and easy access to potential dumping spots. These characteristics are also conducive to irregular dumping (Wright et al. 2018). Within the context of developing countries, Sotamenou et al. (2019) also confirm that neighbourhood and institutional characteristics including accessibility of an area, poor spatial planning or population density are related to non-compliance. In particular, a study on households in Yaoundé, Cameroon, highlights ease of access to legal alternatives as a determinant of irregular dumping: the probability of irregular dumping increases when the distance to the closest drop-off container increases (Sotamenou et al. 2019). A study on illegal dumping in Brussels, Belgium found that an urban environment, particularly the historical area (rather than the neighbourhoods and the green periphery) and narrow, quiet streets are more likely to be sites where illegal dumping takes place (Guyot et al. 2021). A South African study conducted in West Rand District Municipalities describes areas prone to illegal dumping: they are rural, and their communities lack waste storage facilities and good roads, which complicates access in terms of waste collection (Muzenda et al. 2019).

Reported waste crime is also impacted by economic issues, namely scale effects (higher level of economic activity increases waste that can be irregularly dumped) and structural determinants such as income and GDP. Residents with higher income may exhibit more environmental concern and consequently be more likely to report irregular dumping (Almer and Goeschl 2015).

An initial study on the impact of the costs of legal disposal as a cause of irregular dumping indicated that dumping is sensitive to the costs of legal disposal options such as disposal

and reuse and to the threat of enforcement (Sigman 1998). A recent study by Jakiel et al. (2019) also mentions the costs of waste disposal as a factor that increases irregular dumping. Almer and Goeschl (2015) note that irregular waste disposal is overwhelmingly related to economic motives such as the need for saving through bypassing expensive environmental regulations. The dominant research strands in the literature on irregular dumping provide evidence for this notion. Šedová (2016) notes that literature on irregular dumping concentrates on the relation between the pricing system of waste collection and irregular dumping. This confirms the importance of economic disincentives as a determinant of irregular dumping. Discouraging the discharge of garbage by economic disincentives increases the benefit of irregular dumping. Kim et al. (2008) investigated the effect of a unit pricing system on the practice of irregular dumping in Korea and concluded that an increase in the unit price of a trash bag led to an increase in reported incidents of irregular dumping. Although a higher tax on waste discourages waste disposal and generation, a too high tax rate on waste disposal will encourage households and companies to resort to irregular dumping. Apart from increased waste tax, restrictions on the disposal of certain items such as used oil also contribute to irregular dumping (Liu et al. 2017). Coupling an obligation to return certain items (for example, used appliances) with an obligation on consumers to pay recycling and transportation fees in a pay-after-use system, also raises concerns about irregular dumping as noted in research conducted in Japan (Matsumoto and Takeuchi 2011).

In addition, increasing the landfill cost (landfill tax and landfill gate fee) leads to an increase in irregular dumping in the UK (Liu et al. 2017). Apart from the avoidance of tipping fees, another economic disincentive tied to an increase in irregular dumping is the cost of transport (Lu 2019).

Kerbside dumping is a specific subcategory of irregular disposal, referring to the practice of dumping unwanted household goods in urban areas on the footpaths outside residences. Generally, goods might include household furniture, mattresses, green waste, electronic goods and other household items and they are intentionally left outside to be available for passers by. Although these items are sometimes too large for municipal waste collection bins, this may not necessarily be the case. Kerbside dumping is irregular because it increases the financial burden on local government, reduces the amenity for

local residents, might be dangerous and obstructs footpaths. The practice is not restricted to developing countries, but is a particular concern for developed countries where waste collection services are provided. Research on the motivation for kerbside dumping is limited compared to research on littering and other forms of irregular dumping. Initial research on kerbside dumping identified convenience and the provision of help, perceived increased recycling rates, the creation of a social norm of kerbside dumping, ignorance of irregularity, allocation of responsibility to local government and financial constraints as motivations for kerbside dumping (Comerford et al. 2018). Comerford et al. (2018) conducted research on the motivations for kerbside dumping, the acceptability of dumping and the barriers to alternative disposal options in Brisbane, Queensland, Australia. Incentives for kerbside dumping included that it was an effective and convenient way of disposing of items since items were collected quickly. Kerbside dumping was also identified as a common practice in the area. Some residents were not aware that the practice was irregular or that alternative disposal options existed. Residents were also motivated to share discarded items for reuse and did not perceive their items as waste. In addition, lack of storage provided an incentive to dump items on the kerbside. Transportation to a suitable disposal site was problematic, although cost of entry to the disposal point did not present a significant barrier (Comerford et al. 2018).

In terms of predictors of kerbside dumping, correlations between student status and non-English first language status, non-ownership, low income, unemployment or temporary employment, residence in subsidised living areas and kerbside dumping were reported. It appears therefore that kerbside dumping seems to be associated with socio-economic disadvantage (Comerford et al. 2018).

Another category of waste that is often the subject of irregular dumping is construction and demolition waste. A study in Romania by Mihai (2019) focusing on the challenges of this type of dumping and the management stages involved mentions design errors, procurement issues and improper planning, inadequate handling of materials, raw material residues and changes of building design as factors resulting in construction and demolition waste.

Waste trading results in irregular dumping. The lucrative global market for waste enables

the practice of waste trafficking. Some researchers argue that the differences in national regulations and enforcement create an environment conducive to waste trafficking. In terms of particular types of waste, reductions in price for waste materials such as scrap metal can lead to increased costs related to vehicle scrapping and also to the irregular dumping of discarded vehicles (Liu et al. 2017).

Irregular trafficking of waste is a profitable organised crime activity, particularly in southern Italy, where collusion between local institutions and the mafia enables the control of waste markets. Italy is not the only hotspot of irregular waste trafficking and similar criminal activity has been reported in Spain, Greece, France, Romania, Bulgaria and the UK (Navarro et al. 2016). Earlier studies on organised waste crime argued that weak regulatory enforcement of waste legislation leads to organised waste crime. In addition, increasing the cost of legitimate waste treatment services provides an incentive for irregular waste operations (Liu et al. 2017). D'Amato et al. (2015) also studied the influence of the presence of organised crime on waste management and disposal. They found that the presence of organised crimes may worsen waste disposal and irregular dumping. The presence of the mafia, for example, lowered sorted waste collection performance (D'Amato et al. 2015). In addition, since crime networks reach over administrative and geographical jurisdictions, and utilities addressing waste management extend beyond municipal and provincial borders, waste management performance also suffers to a broader extent: sorted waste and legal forms of landfilling are reduced and irregular disposal increases (D'Amato et al. 2015).

Umar and Aondowase (2021) found that ineffective environmental law enforcement is one of the causes of indiscriminate dumping of waste in Jalingo Metropolis, in Nigeria. D'Amato et al. (2018) concluded that a commitment to a more stringent waste policy increases irregular disposal of waste. However, deterrence seems to be related to a relatively high level of implemented controls.

4.3 Current irregular dumping challenges

The cost of addressing irregular dumping is a major challenge, both in terms of prevention, but more so in terms of criminal enforcement and other *ex post* measures, as noted in a study referring to Ash Road, Liverpool Council, Sydney, Australia (Crofts et al.

2010).

The adoption of policy by, for example, integrating the polluter-pays principle can increase irregular dumping and may necessitate the further promulgation of targeted legislation. One of the challenges, as indicated by a study on irregular dumping in Japan, is the continuous amendment of legislation (Fujikura 2011).

Social studies also highlight the complex relationship between societal problems and irregular dumping and, consequently, the complexity of solutions necessary to address irregular dumping in contexts where poverty, apathy and lack of government resources converge. The necessity of legislative reform and the involvement of local government in addressing citizens' concerns about irregular dumping have been highlighted in a sociological study focusing on rural Kentucky, USA (Tunnell 2008). Tunnell (2008) also emphasised that housing and business development should take into account the effect on local communities' and public finances. Social disorganisation, rural and poor financial status increase irregular dumping.

Long-term health effects of irregular dumping were also highlighted in a study on the eastern area of the Campania Region, Southern Italy, where the prevalence of irregular dumping is extremely high and irregular disposal of urban, toxic and industrial wastes results in harmful effects on land, ground and surface water as well as air quality. Previous research has investigated cancer incidence, childhood mortality and birth defects and in a literature review on these studies indicated a positive correlation between the role of waste and liver and lung cancer mortality as well as congenital malformation (Triassi et al. 2015). Other health challenges are associated with the irregular transnational hazardous waste disposal or e-waste involving seemingly legitimate but corrupt companies, irregular disposal methods, terrorist and organised criminal groups. This problem is exacerbated by local irregular dumping as indicated by a study conducted in West Africa (Lambrechts and Hector 2016).

Even if legislation and enforcement are reasonably effective in reducing irregular dumping, remaining sites of irregular dumping pose a challenge in terms of clean-up costs. In addition, new types of irregular dumping emerge, for example, the dumping of

contaminated soil, in turn necessitating new legislation or amendments to existing legislation (Fujikura 2011).

4.4 Identifying irregular dumping sites and detection of dumping

Jakiel et al. (2019) note the necessity of understanding the distribution of irregular waste disposal sites, since this will enhance the cost effectiveness and efficiency of waste management and aids the prioritisation of irregular dumping sites. The latter is necessary because the rehabilitation of all sites is not feasible because of waste quantity and the number of dumping sites. Existing studies focus on methodologies for identifying irregular landfills, mapping irregular dumping sites, remote sensing, aerial infrared thermography, thermal pattern and thermal tracking, crowd-sourced mapping, prediction of the probability of irregular dumping sites (through remote-sensing tools, GIS analysis and multi-criteria evaluation techniques) and identifying irregular dumping by means of publicly available data on waste disposal (Lega et al. 2014; Lu 2019; Jakiel et al. 2019).

Zainun et al. (2016) mapped the irregular dumping of construction waste in the Kluang district, Johor, in Malaysia with GIS software. They collected coordinates, photos, types of material and quantity of waste manually during a three-month site observation period. Waste quantification was done by two methods, namely categorising according to the dimensions of the shape of the waste and by using a weighing approach. They found 12 types of construction waste (concrete, tiles, wood, gypsum board, mixed construction waste, brick and concrete, bricks, sand, iron, glass, pavement and tiles. The highest percentage of dumped waste was mixed waste, followed by concrete and tiles. Waste mapping was done to assist the district authority to improve solid waste management in terms of monitoring and resource efficiency. Construction waste generation is increasing as a result of the rapid development in the construction industry and consequently irregular dumping which increases risks to health and the environment also spreads. In particular the researchers mentioned renovation of houses as a factor that leads to increased irregular dumping.

Indrawati and Purwaningrum (2018) investigated irregular dumping in a river segment in South Jakarta. They mapped the field directly through river trekking by boat and road, using a 50-litre trash bag, and measuring the volume of solid waste at three sampling

locations for three days by continuous sampling. The sampling locations were determined after a preliminary survey. In terms of the solid waste composition, the major component was organic, followed by inorganic waste containing wood, paper, plastic, glass, textile, rubber, metal and other materials. Factors contributing to river pollution were irregular dumping of household waste and an increase in human population accompanied by intensified agricultural and industrial activity. The researchers recommended restoring the function of the riverbanks as green open space, installing a trash rack in the river and implementing solid waste management using the 3R model.

Jakiel et al. (2019) tracked spatial and temporal changes to irregular dumping sites in a nature-protected area for a period of 22 years. The study confirmed that the distribution of irregular waste disposal sites is not random, but affected by the proximity of roads and buildings, land use and topographic location. The most significant factors were the accessibility and proximity of a site and the opportunity to conceal waste disposal. The study also revealed behavioural change: people travelled further to dispose of waste and did not return to the same waste disposal site as was evident from increased dispersion of small dumping sites further from roads and buildings. Large irregular dumping sites decreased in number. Official statistics on irregular dumping differed from the field data and were characterised by underestimated figures. Therefore, the need for reliable data was highlighted. Recommendations to address irregular dumping included awareness raising, environmental impact studies focusing on irregular dumping sites, the installation of signage and surveillance cameras, assistance in patrol scheduling to maximise the detection of irregular dumping and increase risk perception (Jakiel et al. 2019).

Lega et al. (2014) investigated the effectiveness of aerial infrared thermography in the detection of environmental contamination and the enhancement of information on the latter by means of a thermal patterns database. In particular, their research provides measures to pinpoint a crime/guilt relationship which can assist police in identifying perpetrators of environmental crime in general, including irregular dumping.

Ma et al. (2020) studied the use of ArcGIS technology to determine the amount of solid waste dumping. This three-dimensional visualisation method can be used in criminal cases to assist in sentencing.

Lu (2019) used behavioural indicators and data analytics to identify factors contributing to irregular dumping as well as waste hauling trucks potentially involved in irregular dumping. The researcher's crime identification methodology consists of three steps, namely behaviour characterisation, big data analytical model development, and model training, calibration and evaluation.

Coccoli et al. (2022) reported on a proposed solution to illegal dumping utilising automated visual recognition combined with an alert system in a study conducted in Genoa, Italy. The solution is based on the analysis of urban surveillance and traffic monitoring videos through cognitive computing technologies to identify trash and to alert municipalities to waste out of place (Coccoli et al. 2022). However, this solution depends on the integration of different interoperable systems. Devesa and Brust (2021) proposed a data-driven model based on machine learning to analyse satellite images in order to identify the location of irregular dumping sites and monitor their state over time. This solution requires hands-on training of municipal staff.

4.5 Strategies to address irregular dumping

4.5.1 Increased availability of waste collection and facilities

In contexts where irregular dumping is caused by the rejection of waste containers near residential areas or in cities, tractor trailers can be used and the frequency of waste collection can be increased (Tadesse et al. 2008). The problem of insufficient facilities can also be partially addressed by managing organic waste at home, e.g. through in-house or backyard composting, as suggested by Dladla et al. (2016).

4.5.2 Surveillance and reporting systems

The negative impact of irregular dumping activities motivates governments to emphasise the detection of irregular dumping activities. The Global Positioning System and satellite images have been used to detect irregular dumping (Lu 2019). In particular, different methods of zoning have been used to show the potential irregular dumping sites. In this regard, zoning results indicated areas that necessitated patrolling against irregular dumping. Size-based zoning was effective for surveillance against large quantities of irregular dumping but not significantly better than occurrence-based zoning to indicate

sites with higher potential for large irregular dumping, which would be effectively addressed by occurrence-based zoning (Tasaki et al. 2007).

Navarro et al. (2016) investigated the potential of novel real-time GPS tracking of scavenging gull species in order to detect irregular urban dumps rapidly and effectively. Scavenging gulls are attracted to human organic waste and the research indicated how the birds could be used to pinpoint irregular dumping in southern Spain, especially in marine areas. The gulls cover a wide area cost-efficiently compared to conventional land-based surveys. The gulls are not bound by borders, or personal and air-traffic regulations and can visit areas hazardous to the general public or law enforcers.

Solutions to the detection and surveillance of illegal dumping spots based on existing surveillance camera footage and satellite imagery were proposed by Coccoli et al. (2022) and Devesa and Brust (2021) respectively, as discussed in section 4 above. However, these solutions require technical resources, integrated systems and training, and may therefore not be accessible or practical for developing countries. Big data have also been used to identify suspected cases of irregular dumping as research in Hong Kong indicates. The study by Lu (2019) demonstrates how behavioural indicators and big data analytics can be used to identify possible drivers of irregular dumping and vehicles suspected of involvement in irregular dumping. The research highlights three indicators more related to drivers of irregular dumping, namely a waste transportation truck with fewer daily clients, less time spent at government waste facilities, and less depth in the government's waste records. Two significant behavioural drivers were also identified, namely small freelance businesses and long queuing time at waste facilities.

Matsumoto and Takeuchi (2011) note that monitoring and patrol activities by community residents in Japan reduced the amount of irregular dumping. It seems that surveillance and report systems in cooperation with local residents and post offices and or taxi companies are conducive to the reduction of the growth of irregular dumping. Efforts have also been made to encourage public reporting of irregular dumping by means of fly-tipping systems in Hong Kong (Lu 2019). In the UK local authorities and the Environmental Agency were required to report the number, size, waste and location types of irregular dumping since 2004 (Lu 2019). The reporting system in San Jose, California included the

possibility for community members to send complaints concerning illegal dumping (amongst other things) by telephone, online or through an app and to include photos. A study on the programme (Removing and Preventing Illegal Dumping Program (RAPID)) indicated that the objective of the removal of illegal dumped material was met timeously as a result. Moreover, the programme also led to documentation of the motivation for not removing certain dumped items and increased transparency and enabled staff to change incident routes in the city (Laxamana 2019).

4.5.3 Policy

Studies on the role of regulatory policy in contexts with imperfect monitoring and costly enforcement were mainly of a theoretical nature from the 1970s to the early 1990s (Matsumoto and Takeuchi 2011). Earlier work on waste policy in areas where irregular disposal is an issue concluded that an optimal policy would entail a deposit-refund system: tax imposed on the total output along with a rebate on correct disposal and recycling. Initial studies were followed by research on monitoring costs and the effect of transaction costs on the choice of a suitable tool to achieve the second-best policy (D'Amato et al. 2015). In a data mining study conducted by Yang et al. (2019) the authors recommend that waste policy should focus on prediction and prevention rather than ex-post facto management. They state that the surveillance of hot spots should be done intensively, that decreasing the inconvenience of proper waste disposal by improving facilities and services is important, e.g. by improving recycling facilities where illegal dumping is prevalent (Yang et al. 2019). User needs ought to be taken into account, basic services should be extended, waste services in cities should be flexible where large amounts of waste are commonplace, and take into account weather conditions as well as consider public-private collaboration to improve waste services and involve communities, e.g. in monitoring and the development of improvement projects for sites where illegal dumping is prevalent (Yang et al. 2019). A study by Culver et al. (2019) conducted in Upper Cumberland also subscribes to a pre-emptive approach and recommends that abatement programmes related to illegal dumping should firstly obtain information to facilitate effective planning. Based on cost/benefit analysis it can generally be stated that clean-ups are more costly than prevention. However, the study by Culver et al. (2019) also recommends enforcement in the form of penalties, bolstered by sustainability education and regional grants rather than funding for individual municipalities as a policy

approach.

4.5.4 Business improvement districts

Business improvement districts (BIDs) deliver supplemental public services and are authorised by state laws and local governments and approved by property owners. The BID model originated in the USA during the 1960s, but has also been used in Europe, New Zealand and South Africa. In a broader context the theoretical explanation for the reduced crime in BIDs relates to the broken windows and defensible space theories. According to the former, the presence of uniformed officers increases social control, decreases fear and acts as a deterrent of crime. In terms of the later theory, proper design increases the attractiveness of an area and enhances the social interaction and cohesion among business owners and residents, which results in more informal surveillance and crime reduction. These self-assessment districts decrease irregular dumping along with other nuisance crimes such as graffiti and disorderly conduct. Han et al. (2017) studied the effect of BIDs on nuisance crimes in Philadelphia, USA, from 1998–2009. However, the reduction of nuisance crimes was significant only during the first five years of the existence of the BID. This may be due to wearing off of the novelty effect of the BID in its respective area (Han et al. 2017).

4.5.5 Economic incentives

Fullerton and Kinnaman (1995) refer to existing literature proposing garbage taxing as the solution to the negative externality created by refuse, assuming that the disposal options open to households are legal garbage disposal and recycling. However, if irregular burning or dumping is added to the options, and this disposal strategy cannot be taxed directly, the tax on garbage may turn negative. They suggest subsidising garbage collection to address the environmental costs of irregular dumping and taxing output. Their optimal fees structure is a deposit-refund system consisting of a tax on all outputs plus a rebate on proper disposal accomplished by either recycling or garbage collection. Onoda (2012) concluded that enforcement levels impact on household behaviour directly and producers' behaviour indirectly, namely by affecting how much the producer engages in recycling, uses virgin resources and exports waste to a foreign country. If higher levels of enforcement are applied to households, their legal waste disposal increases, but their demand for goods decreases. Although the legal waste disposal increases and may

increase potentially recycled material, the decrease in demand for goods results in lowered production by firms, and decrease in the use of inputs, based on the assumption that the firm can export household waste before recycling.

4.5.6 Criminal law enforcement and enforcement actions

The question of whether environmental monitoring and enforcement are effective has been the subject of research over the last three decades. In particular, this question has been pursued by researchers in the United States (Almer and Goeschl 2015). Earlier research focused on large corporations and criminal organisations as the main contributors to environmental crime in the USA, but subsequently the role of ordinary citizens was also considered. (Situ 1998). Generally, the literature shows that those targeted by enforcement agencies show higher compliance with environmental legislation than individuals and entities who are not. An increase in enforcement also results in an increase in compliance. Apart from this specific deterrence, general deterrence is also observed among the general regulated population (Almer and Goeschl 2015).

In the initial studies on environmental crime, results indicated that education rather than criminal law enforcement would be a better deterrent where the general public is concerned (Situ 1998). The role of education in increasing information available to the public, indicating the harmful consequences of irregular dumping and, in particular, legal alternatives to irregular dumping and the willingness of local government to prosecute were also highlighted by Crofts et al. (2010). These authors argue that prevention is less costly than criminal sanctions. They note that advertising and other educational tools indirectly decrease irregular dumping by challenging social norms concerning irregular dumping and addressing attitudes to the extent that individuals should consider their responsibility for irregular dumping. However, a drawback is that these types of prevention campaigns are mostly effective in decreasing irregular dumping for the duration of the campaign (Crofts et al. 2010).

Almer and Goeschl (2015) studied compliance in the context of waste regulations with the focus on criminal sanctions as enforcement tools. Compared to administrative and civil enforcement tools, they provide more severe sanctions and involve different actors, namely police, public prosecutors and criminal court judges. They found that an increased

probability for criminal sanctions for irregular waste management results in a decrease in waste-related crimes. In addition, the choice of an enforcement tool relies on various mechanisms of general deterrence such as the probability of punishment and publicity risk associated with public prosecution.

Liu et al. (2017) noted that intensive responses against irregular dumping deter crime. Responses may include investigations, warning letters and penalty actions (for example, statutory notice actions, fixed penalty notice actions, duty of care inspection actions, and stop and search actions). The intensity of the penalty for irregular dumping and higher prosecution rates discouraged irregular dumping.

According to D'Amato et al. (2018), high levels of control are key to increased deterrence. The inspections must be sufficiently frequent in order to create a significant and negative correlation between inspections and violations. This might prove a challenge, as an earlier study by D'Amato and Zoli (2012) also conducted in Italy, suggests. The presence of organised crime impacts on waste management significantly in Italy, and specifically the presence of the Mafia. Increasing economic activity also decreases enforcement. A study by Liu et al. (2021) also states that penalties and increases in penalties will not deter illegal dumping of construction and demolition waste if used as a strategy on its own - a level of intense supervision is needed.

Onoda (2012) found that in contexts where the only policy instrument subject to control is enforcement levels – i.e. where the manipulation of enforcement is easier and more practical than other policy devices such as household collection charge and fines for irregular disposal which require legislative and judicial intervention for level change – governments should respond to irregular dumping by households by increasing enforcement, but when exported waste is the issue, enforcement should be decreased. The decision to increase enforcement levels must be based on the most significant environment-related marginal cost. According to Onoda (2012) enforcement levels impact on household behaviour directly and producers' behaviour indirectly. Enforcement levels affect how much the producer engages in recycling, uses virgin resources and exports waste to a foreign country. If higher levels of enforcement are applied to households, their legal waste disposal increases, but their demand for goods decreases. Although the legal

waste disposal increases and may increase potentially recycled material, the decrease in demand for goods results in lowered production by firms, and decrease in the use of inputs, based on the assumption that the firm can export household waste before recycling.

Almer and Goeschl (2015), with reference to the work of Gray and Shimshack (2011), summarise five research issues that still require study, namely international experiences regarding the deterrence effect, the role of industry characteristics, the importance of local factors, the impact of regulatory tools that are not administrative or civil in nature, and the relationship between targeted and general enforcement.

4.5.7 Licencing system

Shinkuma and Managi (2012) have done both theoretical and empirical research on the effectiveness of a licensing system in curbing irregular disposal of waste. On a theoretical level the licensing system has enforcement leverage. According to the conventional model of enforcement leverage, waste disposers may have an incentive to comply with the regulations, even though the cost of the compliance exceeds the expected penalty. The incentive lies in the motivation of the waste disposer to move from a categorisation as a frequent offender marked by regular targeting for inspection and severe fines, to a category labelled law-abiding and therefore less targeted for surveillance and penalties. However, Shinkuma and Managi (2012) demonstrate that enforcement leverage may have another determinant. It can occur by extending liability to disposers to legally oblige them to consign their waste to licensed waste management firms. They conclude that by extending liability to disposers, irregular disposal is more effectively deterred than by increasing penalties for irregular disposal.

4.5.8 Urban street greenery

Greening on dumping sites has been investigated as a preventative measure to curb irregular dumping of household garbage. Household garbage refers to garbage-filled bags and/or end-of-life electrical appliances and furniture originating from an individual household. This strategy is based on the modification of the physical characteristics of the site by landscaping and beautifying locations prone to irregular dumping. Joo and Kwon (2015) concluded, based on a study of a preventative greening project in Suwon,

South Korea, that street greenery does appear to prevent irregular dumping of household waste. However, not all greenery seems to be equally effective. Furthermore, certain physical design elements may enhance the effectiveness by reducing the space available for irregular dumping.

4.5.9 Vehicle impoundment policy

Vehicle impoundment has been implemented as a policy in Israel since 2006 to reduce irregular dumping of construction and demolition waste. Due to difficulties in implementing vehicle impoundment caused by legal requirements such as obtaining warrants to seize vehicles, this policy has not been used widely to address non-traffic-related violations. Seror et al. (2014) investigated the effectiveness of this measure in reducing irregular dumping and as motivation to encourage truck drivers to haul waste to authorised landfill sites in Israel. It was found to be an effective policy tool for reducing the irregular disposal of construction and demolition waste, and to encourage drivers to transport construction and demolition waste to authorised sites. In districts where it was more stringently enforced it was found to be more effective. As Seror et al. (2014) note, continuity and persistence seem to be important factors in the implementation of such an enforcement policy. In addition, vehicle impoundment was found to be more effective than fines and criminal indictment to address construction and demolition waste in a later study in Israel (Seror and Portnov 2020). The authors explain the lack of effectiveness of the other two policy instruments in terms of the low fines imposed, long court proceedings and low probability of being apprehended. Conversely, vehicle impoundment is immediate and has serious economic implications (Seror and Portnov 2020).

4.5.10 Education, outreach and community cohesion

Brandt (2017), with reference to socially disorganised neighbourhoods, in a study of illegal dumping in San José, California, recommended frequent culturally responsive outreaches to inform communities of waste management programmes, for example, free large pick-up programmes, and establishing communication and social networks through, for example, community events and facilitated conversations.

4.6 Management of irregular dumping sites

Different approaches have been conceptualised for the management of irregular dumping

of solid waste. In response to the need to determine dumpsite priorities for intervention because of limited resources, De Feo et al. (2014) defined a multi-criteria web-based approach to identify irregular dumpsites, and to enable the sharing of resources among authorities, technicians and citizens. The application of this approach minimises the social cost of pollution, rehabilitation of dumpsites and the monitoring of irregular dumping. The approach was applied to a village in southern Italy, but could be customised for comparable villages elsewhere.

In terms of specific types of waste, Da Paz et al. (2020) responded to the need to assess the environmental risk arising from construction and demolition waste in Brazil and to identify the most critical locations. Sites were identified by direct observation and photographic registration. Sites were classified according to different aspects. Criteria included distance between the disposal points and water resources, plant cover, subnormal clusters, mean family income, parks and plazas, and health and educational equipment. Use of this classification methodology for risk assessment enables environmental zoning, more efficient inspection and the reduction of costs of environmental monitoring.

Conceptual models for the management of irregular dumping sites by municipal services have been created. Santos et al. (2019) developed a conceptual model for the management of irregular dumping sites of construction and demolition waste based on a social life-cycle assessment. Their model is an open-participatory management tool to supply information needed to decide on an appropriate waste management strategy that can minimise costs, restore ecological value and eliminate public hazards. The social life-cycle assessment combines both socio-economic and environmental assessments of products and services to promote sustainable development.

Once priority sites have been identified for treatment, response actions may differ. Either removal actions or remedial actions take place and cost, time and safety concerns determine the appropriate clean-up action. Sasao (2016) investigated the determinants of removal decisions about dumped waste and contaminated soil. An increase in the amount of dumped waste is an indicator that removal actions (which are more expensive off-site cleanups compared to remedial on-site cleanups) will not be selected. On the

other hand, the presence of toxic materials would predict the selection of removal actions. In higher-income municipalities partial removal is likely. Partial or full removal raises clean-up costs significantly but the clean-up period stays the same regardless of a choice for remedial or removal actions. However, the inclusion of toxic waste can prolong the disposal period by almost 70%.

After clean-up, the land use of the remediated site needs to be considered. Consultation with local governments and residents in the vicinity of the sites is necessary where remediation is funded by public funds. The aim should be to reduce the negative impact of the sites on the natural and socio-economic environment by preventing recurrent irregular dumping and crime, and redeveloping the area. Ishii et al. (2013) identified a method of needs analysis with conjoint analysis to develop a land-use plan after remediation, taking into consideration economic and social feasibility and the potential needs of residents. Within the context of this case study, which was conducted in Aomori-Iwate, Japan, residents had a preference for returning sites to their natural state as well as land use, which would add economic and social value to the region

5. List of references

Abdollahi, A., Mobarakeh, MRV & Karbalaei, S. 2015. Locus of Control, Hardiness and Emotional Intelligence as Predictors of Waste Prevention Behaviours. *Romanian Journal of Applied Psychology*. 17(1):8-16.

Abd'Razack, N.T.A., Medayese, S.O., Shaibu, S.I. & Adeleye B.M. 2017. Habits and Benefits of Recycling Solid Waste Among Households in Kaduna, North West Nigeria. *Sustainable Cities and Society*. 28:297-306.

Abebaw, A. 2019. Determination of Calorific Value and Investigation of Management Option for Household Solid Waste from Kilinto Condominium Site. MSc Thesis. Department of Environmental Engineering, Addis Ababa Science and Technology University.

Abegaz, S.B., Molla, K.A. & Ali S.E. 2021. Practices and Challenges of Household Solid Waste Management in Woldia Town, Northeastern Ethiopia. *Journal of Health and Pollution*. 11(30):1-12.

Abubakar, I.R. 2017. Household Response to Inadequate Sewerage and Garbage Collection Services in Abuja, Nigeria. *Journal of Environmental and Public Health*. 1-11.

Acharya, A., Bastola, G., Modi, B., Marhatta, A., Belhase, S., Lamichhane, G., Gyawali, N. & Dahal, R.K. 2021. The Impact of COVID-19 outbreak and Perceptions of People towards Household Waste Management Chain in Nepal. *Geoenvironmental Disasters*. 8(14):1-11. <https://doi.org/10.1186/s40677-021-00188-w>

Adam, S.U., Shamsudin, M.N, Sidique, S.F., Abdul Rahim, K. & Radam, A. 2014. Determinants of Privatized Solid Waste Management Service Provision in Lagos. *Journal of Environmental Planning and Management*. 1-23.

Addo-Yobo, F.N. & Mansoor, A. 2003. Households: Passive Users or Active Managers? The Case of Solid Waste Management in Accra, Ghana. *International Development Planning Review*. 25(4):373-389.

Address M.J.J. & Gunawardena, U.A.D.P. 2020 Household Preferences and Willingness to Pay for Improved Solid Waste Management Services in Colombo 15, Sri Lanka [Abstract]. Proceedings of the 25th International Forestry and Environment Symposium. *Environmental Economics in Resource Management*.

Afroz, R., Tudin, R., Keisuke, H. & Masud, M.M. 2011. Selected Socio-economic Factors Affecting the Willingness to Minimise Solid Waste in Dhaka City, Bangladesh. *Journal of Environmental Planning and Management* 54(6):711-731.

Agamuthu, P., Fauziah, S.H., Khidzir, K.M. and Noorzamimah, A.A. 2007. Sustainable Waste Management in Asian Perspectives. *Proceedings of the International Conference on Sustainable Solid Waste Management*. 5 -7 September 2007. Chennai, India.

Aggenbag, M.H.S. 2012. Waste Management Best Practice by Municipal / Environmental Health Services at Joe Gqabi District Municipality in the Eastern Cape Province. *Proceedings of the 2^{1st} Waste Management Conference and Exhibition*. 9 – 12 October 2012. East London, South Africa.

Aguadze, G. 2020. *The Role of Stakeholders in the Management of Household Solid Waste in New Juaben Municipality, Ghana*. MSc Thesis. Environmental Health and Sanitation, Presbyterian University College, Ghana.

Agyei-Mensah, S. & Oteng-Ababio, M. 2012. Perceptions of Health and Environmental Impacts of E-Waste Management in Ghana. *International Journal of Environmental Health Research*. 22(6):500-517.

Aini, M.S., Razi, A.F., Lau, S.M. & Hashim, A. H. 2002. Practices, attitudes and motives for domestic waste recycling. *International Journal of Sustainable Development and World Ecology*. 9(3):232.

Ajani, A.O. & Fakunle, S.O. 2021. Community Participation: The Cornerstone for the Efficiency of Institutional Frameworks for Household Solid Waste Management in Low-income Residential Areas in Nigeria. *American International Journal of Supply Chain Management*. 2(1):37-45.

Akhtar, R., Masud, M.M. & Afroz, R. 2013. Household Perception and Recycling Behaviour on Electronic Waste Management: A Case Study of Kuala-Lumpur, Malaysia. *Malaysian Journal of Science*. 33:32–41. <https://doi.org/10.22452/mjs.vol33no1.5>

Akintola, B.A., Temowo, O.O. & Ajiboye, J.O. 2009. Media Choice in Environmental Information Dissemination for Solid Waste Management among Policy Formulators and Implementors: A Case Study of Oyo State, Nigeria. *Applied Environmental Education & Communication*. 8(1):59-66.

Akmal, T. & Jamil, F. 2021. Health Impact of Solid Waste Management Practices on Household: The Case of Metropolitans of Islamabad-Rawalpindi, Pakistan. *Heliyon* .

Akpoghiran, I.P. 2020. Engaging Media Advocacy on Self-littering of the Environment in Nigeria. *Global Journal of Social Sciences*. 9. <https://doi.org/10.4314/gjss.v19i1.6>

Alam, P. & Ahmade, K. 2013. Impact of Solid Waste on Health and the Environment. *Special Issue of International Journal of Sustainable Development and Green Energy*. 2(1):165-168.

Aleisa, E. & Rawa, A. 2018. A Triple Bottom Line Evaluation of Solid Waste Management Strategies: A Case Study for an Arid Gulf State, Kuwait. *International Journal of Life Cycle Assessment*. 23:1460-1475.

Al-Khatib, I.A. 2009. Children's Perceptions and Behavior with Respect to Glass Littering in Developing Countries: A Case Study in Palestine's Nablus District. *Waste Management*. 29(4):1434-1437.

Al-Khatib, I., Abu Hammad, A., Sharkas, O.A. & Sato, C. 2015 Public Concerns about Perceptions of Solid Waste Dump Sites and Selection of Sanitary Landfill Sites in the West Bank, Palestinian Territory. *Environmental Monitoring and Assessment*. 187(4):1-15.

Al-Khatib, I.A., Ajlouny, H., Al-Sari, M.I. & Kontogianni, S. 2014. Residents' concerns and attitudes toward solid waste management facilities in Palestine: A case study of Hebron District. *Waste Management and Research*. 32(3):228-236.

Al-Khatib, I.A., Arafat, H.A., Daoud, R. & Shwahneh, H. 2009. Enhanced Solid Waste Management by Understanding the Effects of Gender, Income, Marital Status, and Religious Convictions on Attitudes and Practices Related to Street Littering in Nablus – Palestinian Territory. *Waste Management*. 29(1):449-455.

Al-Khatib, I.A., Kontogianni, S., Abu Nabaa, H., Alshami, N. & Al-Sari, M.I. 2015. Public perception of hazardousness caused by current trends of municipal solid waste management. *Waste Management*. 36:323–330.

Allesch, A. & Brunner, P.H. 2017. Material Flow Analysis as a Tool to improve Waste Management Systems: The Case of Austria. *Environmental Science & Technology*. 51(1):540-551.

Almer, C. & Goeschl, T. 2015. The Sopranos Redux: The Empirical Economics of Waste Crime. *Regional Studies*. 49(11):1908-1921.

Almosa, Y., Parkinson, J. & Rundle-Thiele, S. 2020. Preventing Littering: It's Not All About Sticks! *Journal of Nonprofit & Public Sector Marketing*. <https://doi.org/10.1080/10495142.2020.1865236>

Altaf, M. & Deshazo, J. 1996 Household Demand for Improved SWM: A Case Study of Gujranwala, Pakistan. *World Development*. 24(5):857-868.

Alter, H. 1991. The Future Course of Solid Waste Management in the US [Abstract]. *Waste Management & Research*. 9(1):3-20.

Alwedyan, S. 2021. The Urban Household Solid Waste Generating Factors and Composition Study— A Case Study: Irbid City – Jordan. (2021) *Environmental Quality Management*. 1–14. <https://doi.org/10.1002/tqem.21808>

Amankwah-Poku, M. & Ofori, G. 2020. 'People Have Been Paid to Sweep the Place!' - Exploring the Antecedents of Littering Behaviour in Ghana. *Ghana Social Science Journal*. 17(1):93-107.

Amarasinghe, S.R. & Fernando, F.F.H.G. 2014. Pro-environmental Behavior Regarding Solid Waste Management in Householders of Kalutara Urban Council Area – A Case Study. *Journal of Tropical Forestry and Environment*. 4(1):80-84.

Amin, N., Mahmood, S & Hossain, M. 2005. People's Perception of the Existing Solid Waste Management of Khulna City Corporation (KCC) Area: A Case Study of Participatory. The National Workshop for REGA and CDM Awareness Building & Motivation under the ADB PREGA Project in the Western Inn. Ltd. Khulna, Bangladesh.

Amutenya, N., Shackleton, C.M. & Whittington-Jones, K. 2009. Paper Recycling Patterns and Potential Interventions in the Education Sector: A Case Study of Paper Streams at Rhodes University, South Africa. *Resources, Conservation and Recycling*. 53:237-242.

Anand, P.B. 2000. Co-operation and the Urban Environment: An Exploration. *The Journal of Development Studies*. 36(5):30-58.

Anantharaman, M. 2014. Networked Ecological Citizenship, the New Middle Classes and the Provisioning of Sustainable Waste Management in Bangalore, India. *Journal of Cleaner Production*. 63:173-183.

Andersson, C. and Stage, J. 2018. Direct and indirect effects of waste management policies on household behavior: The case of Sweden. *Waste Management*. 76:19-27.

Aparcana, S. 2017. Approaches to Formalization of the Informal Waste Sector into Municipal Solid Waste Management Systems in Low- and Middle-income Countries: Review of Barriers and Success Factors. *Waste Management*. 61:593-60.

Aparcana, S. & Salhofer, S. 2013. Development of a Social Impact Assessment Methodology for Recycling Systems in Low-income Countries. *The International Journal of Life Cycle Assessment*. 18:1106-1115.

Apinpath, C. 2014. Community Mapping and Theory of Planned Behaviour as Study Tools for Solid Waste Management. *Journal of Waste Management*. 1-7.

Aprilia, A., Teuka, T. & Spaargaren, G. 2013. Inorganic and Hazardous Solid Waste Management: Current Status and Challenges for Indonesia. *Procedia Environmental Sciences*. 17:640-647.

Aretoulaki, E., Ponis, S. & Plakas, G. 2021. Marine Plastic Littering: A Review of Socio Economic Impacts. *Journal of Sustainability Science and Management*. 16(3):276-300.

Aschemann-Witzel J., De Hooge, I., Amani, P., Bech-Larsen, T. & Oostindjer, M. 2015. Consumer-Related Food Waste: Causes and Potential for Action. *Sustainability*. 7:6457-6477.

Astane, A.R.D. & Hajilo, M. 2017. Factors affecting the rural domestic waste generation. *Global Journal of Environmental Science and Management*. 3(4):417-426.

Ayew, B. Tilahun, A., Erifo, S. & Tesfaye, P. 2019. Household willingness to pay for improved solid waste management in Shashemene Town, Ethiopia. *African Journal of Environmental Science and Technology*. 13(4): 162-171.

Awunor, N.S., Okhimambe, A.F., Alenoghena, I.O., Abah, S.O., Aremu, A.B., Oyibo, P.G. & Okumagba, M.T. 2021. Determinants of Street Littering in an Urban Setting in South-South Nigeria. *Western Journal of Med & Biomedical Sciences*. 2(2):93-101.

Awunyo-Vitor, D., Ishak, S. & Jasaw, G.S. 2013. Urban Households' Willingness to Pay for Improved Solid Waste Disposal Services in Kumasi Metropolis, Ghana. *Urban Studies Research*. 1-8.

Aziz, N.A.A., Lukhman, A.A., Chubo, J.K. & Daud, D.S.R.A. 2019. Public Perception to Littering in Greenspaces: A Case Study in Bintulu, Sarawak, Malaysia. *Journal of Physics: Conference Series (12th Seminar on Science and Technology)*. 1-9. doi:10.1088/1742-6596/1358/1/012031

Babaei, A.A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K. & Rafiee, M. 2015. Household Recycling Knowledge, Attitudes and Practices towards solid waste management. *Resources, Conservation and Recycling*. 102:94-100.

Balasubramaniam, A. & Vouloulis, N. 2005. The Appropriateness of Multicriteria Analysis in Environmental Decision-Making Problems. *Environmental Technology*. 26(9):951-962.

Baltes, M.M. & Hayward, S.C. 1976. Application and Evaluation of Strategies to Reduce Pollution: Behavioral Control of Littering in a Football Stadium. *Journal of Applied Psychology*. 61(4): 501-506.

Banjo, A.D., Adebambo, A.A.R. & Haight, M. 2009. Inhabitants' Perception on Domestic Waste Disposal in Ijebu Ode, Southwest Nigeria. Department of Biological Sciences, Tai Solarin University of Education.

Barbale, M., Chinaglia, S., Gazzilli, A., Pischedda, A., Pognani, M., Tosin, M. & Degli-Innocenti, F. 2021. Hazard Profiling of Compostable Shopping Bags. Towards an Ecological Risk Assessment of Littering. *Polymer Degradation and Stability*. 188:1-11. <https://doi.org/10.1016/j.polymdegradstab.2021.109592>

Barboza, J.C., Morales, H., Barrantes, R.A., Moreno, A.S. & Lwanga, E.H. 2011. Perceptions and Attitudes Regarding Organic Waste: Feasibility of Establishing an Urban Composting Program in Chiapas, Mexico. *Journal of Agriculture, Food Systems and Community Development*. 1(3): 115-132. <http://dx.doi.org/10.5304/jafscd.2010.013.006>

Barnes, R.L. 2011. Regulating the Disposal of Cigarette Butts as Toxic Hazardous Waste. *Tobacco Control*. 20 (Supplement 1: The Environmental Burden of Cigarette Butts): i45-i48. <https://doi.org/10.1136/tc/2010.041301>

Barr, S. 2007. Factors Influencing Environmental Attitudes and Behaviors. A U.K. Case Study of Household Waste Management. *Environment and Behavior*. 39(4):435-473.

Bateson, M., Callow, L., Holmes, J.R., Redmond Roche, M.L. & Nettle, D. 2013. Do Images of 'Watching Eyes' Induce Behaviour That Is More Pro-social or More Normative? A Field Experiment on Littering. *PLoS ONE*. 8(12): e82055. doi:10.1371/journal.pone.0082055

Bateson, M., Robinson, R., Abayomi-Cole, T., Greenlees, J., O'Connor, A. & Nettle, D. 2015. Watching Eyes on Potential Litter Can Reduce Littering: Evidence from Two Field Experiments. *PeerJ - Life and Environment*. <https://doi.org/10.7717/peerj.1443>

Beeharry, Y.D., Bekaroo, G., Bokhoree, C., Phillips, M.R. & Jory, N. 2017. Sustaining Anti-littering Behavior Within Coastal and Marine Environments. *Marine Pollution Bulletin*. 119:87-99 <http://dx.doi.org/10.1016/j.marpolbul.2017.04.029>

Begum, R.A., Siwar, C., Pereira, J.J. & Jaafar, A.H. 2007. Factors and Values of Willingness to Pay for Improved Construction Waste Management – A Perspective of Malaysian Contractors. *Waste Management* 27(12):1902-1909.

Bello, I.A., Bin Ismail, M. & Kabbashi, N.A. 2016. Solid Waste Management in Africa: A Review. *International Journal of Waste Resources*. 6(2):1-4.

Bemelmans-Videc, M., Rist, R. C., & Vedung, E. (Eds.). 2010. Carrots, Sticks & Sermons (5th ed.). New Brunswick (U.S.A.) and London (U.K.): Transaction Publishers.

Benartzi, S., Beshears, J., Milkman, K.L., Sunstein, C.R., Thaler, R.H., Shankar, M., Tucker-Ray, W., Congdon, W.J. & Galing, S. 2017. Should Governments Invest More in Nudging? *Psychological Science*. 28(8):1041-1055.

Benyam, A., Kinnear, S. & Rolfe, J. 2018. Integrating Community Perspectives into Domestic Food Waste Prevention and Diversion Policies. *Resources, Conservation & Recycling*. 134:174-183.

Berthomé, G. & Thomas, A. 2017. A Context-based Procedure for Assessing Participatory Schemes in Environmental Planning. *Ecological Economics*. 132:113-123.

Bhuiyan, S.H. 2010. A Crisis in Governance: Urban Solid Waste Management in Bangladesh. *Habitat International*. 34(1):125-133.

Boadi, K.O. & Kuitunen, M. 2003. Municipal Solid Waste Management in the Accra Metropolitan Area, Ghana. *The Environmentalist*. 23:211-218.

Boateng, K.S., Agyei-Baffour, P., Boateng, D., Rockson, G.N.K., Mensah, K.A. & Edusei, A.K. 2019. Household Willingness-to-Pay for Improved Solid Waste Management Services in Four Major Metropolitan Cities in Ghana. *Journal of Environmental and Public Health*. 1-9. <https://doi.org/10.1155/2019/5468381>

Boemi, S.N., Papadopoulos, A.M., Karagiannidis, A. & Kontogianni, S. 2010. Barriers on the Propagation of Renewable Energy Sources and Sustainable Solid Waste Management Practices in Greece. *Waste Management & Research*. 28(11):967-976.

Bolaane, B. 2006. Constraints to Promoting People Centred Approaches in Recycling. *Habitat International*. 30:731-740.

Bom, U.B., Belbase, S. & Lila, R.B. 2017. Public Perceptions and Practices of Solid Waste Recycling in the City of Laramie in Wyoming, USA. *Recycling*. 2(3):11.

Bonarrigo, P., Iaconis, M., Johnson, R.D. & McCann, B. 2020. Using Behavior-Change Strategies to Reduce Littering in Lambeth. Interactive Qualifying Project Report, Bachelor of Science, Worcester Polytechnic Institute.

Bonginkosi, R.D., Rampedi, I.T. & Ifegbesan, A.P. 2017. Community Residents' Opinions and Perceptions on the Effectiveness of Waste Management and Recycling Potential in the Umkhanyakude and Zululand District Municipalities in the KwaZulu-Natal Province of South Africa. *Sustainability*. 9(10):1-19.

Bortoleto, A.P., Kurisu, K.H. & Hanaki, K. 2012. Model Development for Household Waste Prevention Behaviour. *Waste Management*. 32(12):2195-2207.

Bose, A. & Blore, I. 1993. Public Waste and Private Property. An Enquiry into the Economics of Solid Waste in Calcutta. *Public Administration and Development*. 13(1):1-15.

Boyle, C.A. 2000. Solid Waste Management in New Zealand. *Waste Management*. 20:517-526.

Brandt, A. 2017. *Illegal Dumping as An Indicator for Community Social Disorganization and Crime*. MSc Thesis. Department of Environmental Studies, San José State University.

Brown, T.J., Ham, S.H. & Hughes, M. 2010. Picking Up Litter: An Application of Theory-based Communication to Influence Tourist Behaviour in Protected Areas. *Journal of Sustainable Tourism*. 18(7):879–900.

Brugman, J. 1992. Managing human ecosystems: Principles for ecological municipal management. Toronto: International Council for Local Environmental Initiatives (ICLEI). Toronto, Canada.

Campbell, M.L., Slavin, C., Garage, A. & Kinslow, A. 2016. Human Health Impacts from Litter on Beaches and Associated Perceptions: A Case Study of 'Clean' Tasmanian Beaches. *Ocean & Coastal Management* 126: 22-30. <http://dx.doi.org/10.1016/j.ocecoaman.2016.04.002>

Caniato, M., Tudor, T. & Vaccari, M. 2015. Understanding the Perceptions, Roles and Interactions of Stakeholder Networks Managing Health-care Waste: A Case Study of the Gaza Strip. *Waste Management*. 35:255-264.

Carmi, N. 2019. On Social Distress, Littering and Nature Conservation: The Case of Jisr A-Zarka. *Coastal Management*. 1-15. <https://doi.org/10.1080/08920753.2019.1598223>

Carrizales, T. & Bainbridge, J. 2013. International Sanitation Management and Performance Measurement: Taking out the Trash. *International Journal of Public Administration*. 36(7):505-511.

Castaldi, G., Cecere, G. & Zoli, M. 2021. "Smoke on the Beach": On the Use of Economic vs Behavioral Policies to Reduce Environmental Pollution by Cigarette Littering. *Economia Politica* 38:1025–1048. <https://doi.org/10.1007/s40888-020-00205-5>

Cecere, G., Mancinelli, S. & Mazzanti, M. 2014. Waste Prevention and Social Preferences: The Role of Intrinsic and Extrinsic Motivations. *Ecological Economics*. 107:163-176.

Chalak, A., Abou-Daher, C. & Abiad, M.G. 2018 Generation of Food Waste in the Hospitality and Food Retail and Wholesale Sectors: Lessons from Developed Economies. *Food Security*. 10:1279-1290.

Cham, L.N., Huong, N.L., Nga, T.T.V., Isobe, Y., Kawasaki, M. and Kawamoto, K. 2021. Construction and Demolition Waste Illegal Dumping: Environmental, Social and Economic Impacts Assessment for a Growing City. Proceedings of the Third International Symposium on Coupled Phenomena in Environmental Geotechnics. Japanese Geotechnical Society Special Publication. 148-155.

Chandra, C., Valentina, A. and Nurannisa, S. 2021. Creative strategy to reduce littering for hikers. *Proceedings of the International Conference on Economics, Business, Social, and Humanities (ICEBSH 2021)*.

Chang, L.C. 2010. The effects of moral emotions and justifications on visitor's intention to pick flowers in a forest recreation area in Taiwan. *Journal of Sustainable Tourism*. 18(1):137–150.

Chaudhary, A.H., Polonsky, M.J. & McClaren, N. 2021. Littering Behaviour: A Systematic Review. *International Journal of Consumer Studies*. 45(4):478-510. <https://doi.org/10.1111/ijcs.12638>

Che, Y., Yang, K., Jin, Y., Zhang, W., Shang, Z. & Tai, J. 2013. Residents' Concerns and Attitudes toward a Municipal Solid Waste Landfill: Integrating a Questionnaire Survey and GIS Techniques. *Environmental Monitoring and Assessment*. 185:10001-10013.

Chenayah, S., Agamuthu, O., & Takeda, E. 2007. Multi-criteria modelling on recycling of municipal solid waste in Subang Jaya, Malaysia. *Journal of Science*. 26:1-16.

Chifari, R., Lo Piano, S., Bukkens, S.G.F. & Giampietro, M. 2018. A Holistic Framework for the Integrated Assessment of Urban Waste. *Ecological Indicators*. 94:24-36.

Chifari, R., Renner, A., Lo Piano, S., Ripa, M., Bukkens, S.G.F. & Giampietro, Mario. 2017. Development of a Municipal Solid Waste Management Decision Support Tool for Naples, Italy. *Journal of Cleaner Production*. 161:1032-1042.

Chong, A., Karlan, D., Shapiro, J. & Zinman, J. 2013. (Ineffective) Messages to Encourage Recycling: Evidence from a Randomized Evaluation in Peru. Policy Research Working Paper 6549, The World Bank.

Choon, S-W., Tan, S-H. & Chong, L-L. 2017. The Perception of Households About Solid Waste Management Issues in Malaysia. *Environment, Development Sustainability*. 19(5):1685-1700.

Christensen, D. & Bach, L.T. 2015. A Danish-Vietnamese Partnership for Business and Technology Development in Solid Waste management. *Resources, Conservation & Recycling*. 105:123-133.

Chu, A.M.Y. 2021. Illegal Waste Dumping Under a Municipal Solid Waste Charging Scheme: Application of the Neutralization Theory. *Sustainability*. 13(16). <https://doi.org/10.3390/su13169279>

Chung, D., Muda, A., Omar, C.M.C. & Manaf, L.A. 2012. Residents' Perceptions of the Visual Quality of On-Site Wastes Storage Bins in Kuching. *Procedia – Social and Behavioral Sciences*. 49:227-236.

Cialdini, R.B. 2003. Crafting Normative Messages to Protect the Environment. *Current Directions in Psychological Science*. 12(4):105-109.

Cingolani, A.M., Barberá, I., Renison, D. & Barri, F.R. 2016. Can Persuasive and Demonstrative Messages to Visitors Reduce Littering in River Beaches? *Waste Management*. 58: 34-40. <http://dx.doi.org/10.1016/j.wasman.2016.08.028>

Civancik-Uslu, D., Puig, R., Hauschild, M. & Fullana-i-Palmer, P. 2019. Life Cycle Assessment of Carrier Bags and Development of a Littering Indicator. *Science of the Total Environment*. 685:621-630.

Clark, C., Jambeck, J. & Townsend, T. 2006. A Review of Construction and Demolition Debris Regulations in the United States. *Critical Reviews in Environmental Science and Technology*. 36(2)141-186.

Coban, A., Ertis, I.F., Cavdaroglu, N.A. 2018. Municipal Solid Waste Management via Multi-Criteria Decision Making Methods: A Case Study in Istanbul, Turkey. *Journal of Cleaner Production*. 180:159-167.

Cobbinah, P.B., Addaney, M.. & Agyeman, K.O.. 2017. Locating the Role of Urbanites in Solid Waste Management in Ghana. *Environmental Development*. 24:9-21.

Coccoli, M., De Francesco, V., Fusco, A. & Maresca, P. 2022. A Cloud-based Cognitive Computing Solution With Interoperable Applications to Counteract Illegal Dumping in Smart Cities. *Multimedia Tools and Applications*. 81:95-113 <https://doi.org/10.1007/s11042-021-11238-8>

Coelho, H.M.G., Lange, L.C. & Coelho, L.M.G. 2012. Proposal of an Environmental Performance Index to Assess Solid Waste Treatment Technologies. *Waste Management*. 32(7):1473-1481.

Comerford, E., Durante, J., Goldsworthy, R., Hall, V., Gooding, J. & Quinn, B. 2018. Motivations for Kerbside Dumping: Evidence from Brisbane, Australia. *Waste Management*. 78:490-496. <https://doi.org/10.1016/j.wasman.2018.06.011>

Corsini, Filippo, Gusmerotti, Natalia M, Testa, Francesco & Iraldo, Fabio “Exploring Waste Prevention Behaviour through Empirical Research” (2018) 79 *Waste Management* 132-141

Corvellec, H. 2016. A Performative Definition of Waste Prevention. *Waste Management*. 52:3-13.

Covey, S.K. & Shew, D. 2000. Building Partnerships – the Ohio Materials Exchange. *Resources, Conservation & Recycling*. 28(3):265-277.

Cristóbal, J., Castellani, V., Manfredi, S. & Sala, S. 2018. Prioritizing and Optimizing Sustainable Measures for Food Waste Prevention and Management. *Waste Management*. 72:3-16.

Crofts, P., Morris, T., Wells, K. & Powell, A. 2010. Illegal Dumping and Crime Prevention: A Case Study of Ash Road, Liverpool Council. *Public Space: The Journal of Law and Social Justice*. 5(4):1-23.

Culver, M., Durham, J., Shanklin, S, Bolan, M. & Fox, P. 2019. *GIS Analysis of Illegal Dumping in the Upper Cumberland and Recommendations for Abatement*.

Dai, X., Han, Y., Zhang, X., Hu, W., Huang, L., Duan, W., Li, S., Liu, X. & Wang, Q. 2017. Comparison between Students and Residents on Determinants of Willingness to Separate Waste and Waste Separation Behaviour in Zhengzhou, China. *Waste Management & Research*. 35(9):949-957.

D’Amato, A., Mancinelli, S. & Zoli, M. 2016. Complementarity vs substitutability in waste management behaviors. *Ecological Economics*. 123:84-94.

D’Amato, A., Mazzanti, M., Nicolli, F. & Zoli, M. 2018. Illegal Waste Disposal. Enforcement Actions and Decentralized Environmental Policy. *Socio-Economic Planning Sciences*. 64:56-65.

D’Amato, A., Mazzanti, M. & Nicolli, F. 2015. Waste and Organized Crime in Regional Environments: How Waste Tariffs and the Mafia Affect Waste Management and Disposal. *Resources and Energy Economics*. 41:185-201.

D’Amato, A. & Zoli, M. 2012. Illegal Waste Disposal in the Time of the Mafia: A Tale of Enforcement and Social Well Being. *Journal of Environmental Planning and Management*. 55(5):637-655.

Damigos, D., Menegaki, M. & Kaliampakos, D. 2016. Monetizing the Social Benefits of Landfill Mining: Evidence from a Contingent Valuation Survey in a Rural Area in Greece. *Waste Management*. 51:119-129.

Da Paz, D.H.F., Lafayette, K.P.V., Holanda, M.J.d., Do Carmo Martins Sobral, M. 2020. Assessment of Environmental Impact Risks Arising from the Illegal Dumping of Construction Waste in Brazil. *22 Environment, Development and Sustainability*. 22:2289-2304. <https://doi.org/10.1007/s10668-018-0289-6>

Davies, A.R. 2012. Geography and the Matter of Waste Mobilities. (2012) 37 (2) *Transactions of the Institute of British Geographers*. 37(2).191-196.

Department of Environment, Forestry and Fisheries and Department of Science and Innovation (DEFF) 2020. Waste picker integration guideline for South Africa: Building the Recycling Economy and Improving Livelihoods through Integration of the Informal Sector. DEFF and DST: Pretoria.

De Feo, G., Cerrato, F., Siano, P. & Torreta, V. 2014. Definition of a Multi-criteria, Web-based Approach to Managing the Illegal Dumping of Solid Waste in Italian Villages. *Environmental Technology*. 35(1):104-114. <https://doi.org/10.1080/09593330.2013.816328>

De Francesco, M.C., Carranza, M.L., Varricchione, M., Tozzi, F.P. & Stanisci, A. 2019. Natural Protected Areas as Special Sentinels of Littering on Coastal Dune Vegetation. *Sustainability*. 11(19). <https://doi.org/10.3390/su11195446>

De Lange, M.A., Debets, L.W., Ruitenburg, K. & Holland, R.W. 2012. Making Less of a Mess: Scent Exposure as a Tool for Behavioral Change. *Social Influence*. 7(2):90-97. <https://doi.org/10.1080/15534510.2012.659509>

Del Cimmuto, A., Mannocci, A., Ribatti, D., Boccia, A. & La Torre, G. 2014. Impact on Knowledge and Behaviour of the General Population of Two Different Methods of Solid Waste Management: An Explorative Cross-Sectional Study. *Waste Management and Research*. 32(6):556-561.

De Morais Vieira, V.H.A. & Matheus, D.R. 2018. The Impact of Socioeconomic Factors on Municipal Solid Waste Generation in São Paulo, Brazil. *Waste Management & Research*. 36(1):79-85.

De Sadeleer, I., Askham, C., Baxter, J. & Stensgard, A. 2021. *Integration of plastic littering in LCA methodology and eco-design tips for the avoidance of littering*. Report. (2021) Norwegian Institute for Sustainability Research (NORSUS).

Devesa, M.R. & Brust, A.V. 2021. Mapping Illegal Waste Dumping Sites with Neural-network Classification of Satellite Imagery. *KdD Humanitarian Mapping Workshop '21, August 14-18, 2021, Virtual Conference*.

Dhahir, D.F. 2020. Shaping and Maintaining Anti-littering Behavior of the Community in Indonesia. *IOP Conference Series: Earth and Environmental Science*. 575 doi:10.1088/1755-1315/575/1/012212

Dias, S.M. 2016. Waste Pickers and Cities. *Environment and Urbanization*. 28(2):375-390.

Dijksterhuis, A. & Van Knippenberg, A. 1998. The Relation between Perception and Behavior, or How to Win a Game of Trivial Pursuit. *Journal of Personality and Social Psychology*. 74(4): 865-877.

Dladla, I., Machete, M. & Shale, K. 2016. A Review of Factors Associated with Indiscriminate Dumping of Waste in Eleven African Countries. *African Journal of Science, Technology, Innovation and Development*. 8(5-6):475-481.

Dladla, I., Machete, M. & Shale, K. 2021. Environmental Health Risks Associated with Indiscriminate Dumping in Lekwa Local Municipality. *African Journal of Science, Technology, Innovation and Development*. 13(1):81-87. <https://doi.org/10.1080/20421338.2020.1818919>

Dlamini, B.R., Rampedi, I.T. & Ifegbesan, A.P. 2017. Community Resident's (*sic*) Opinions and Perceptions on the Effectiveness of Waste Management and Recycling Potential in the Umkhanyakude and Zululand District Municipalities in the KwaZulu-Natal Province of South Africa. *Sustainability*. 9(10). doi:10.3390/su9101835

Doherty, J. 2019. Maintenance Space: The Political Authority of Garbage in Kampala, Uganda. *Current Anthropology*. 60(1):1-23.

Doorasamy, M. 2016. The Perceptions of Management on the Benefits of Adopting an Environmental Management Accounting System as a Waste Management Tool. *Foundations of Management*. 8(1):93-106.

Dos Muchangos, L., Tokai, A. & Hanashima, A. 2015. Analyzing the Structure of Barriers to Municipal Solid Waste Management Policy Planning in Maputo City, Mozambique. *Environmental Development*. 16:76-89.

Du, L., Xu, H. & Zuo, J. 2021. Status Quo of Illegal Dumping Research: Way Forward. *Journal of Environmental Management* <https://doi.org/10.1016/j.jenvman.2021.112601>

Ebrahimi, K. & North, L.A. 2017. Effective Strategies for Enhancing Waste Management at University Campuses. *International Journal of Sustainability in Higher Education*. 18(7):1123-1141.

Eckert, H. 2004. Inspections, Warnings and Compliance: The Case of Petroleum Storage Regulation. *Journal of Environmental Economics and Management*. 47: 232-259.

Elhamdouni, D., Arioua, A., Karaoui, I., Baaddi, A. & Ouhamchich, K.A. 2019. Household Solid Waste Sustainable Management in the Khenifra Region, Morocco. *Arabian Journal of Geosciences*. 12(744). <https://doi.org/10.1007/s12517-019-4960-5>

El Hanandeh, A. & El-Zein, A. 2010. Life-cycle Assessment of Municipal Solid Waste Management Alternatives with Consideration of Uncertainty: SIWMS Development and Application. *Waste Management*. 30:902-911.

Elmore, R. F. 1987. Instruments and strategy in public policy. *Policies Studies Review*. 7(1), 174–186.

Ernest-Jones, M., Nettle, D. & Bateson, M. 2011. Effects of Eye Images on Everyday Cooperative Behavior: A Field Experiment. *Evolution and Human Behavior*. 32: 172-178. doi:10.1016/j.evolhumbehav.2010.10.006

Don't Mess with Texas. <http://www.dontmesswithtexas.org/the-campaign/ad-archive/30-years-of-texas-spirit/>.

Esmailian, B., Wang, B., Lewis, K., Duarte, F., Ratti, C. & Behdad, S. 2018. The Future of Waste Management in Smart and Sustainable Cities: A Review and Concept Paper. *Waste Management*. 81:177-195.

Ezebilo, E & Animasaun, E. 2011. Households' Perceptions of Private Sector Municipal Solid Waste Management Services: A Binary Choice Analysis. *International Journal of Environmental Science & Technology*. 8(4):677-686.

Fahmi, W.S. 2005. The Impact of Privatization of Solid Waste Management on the Zabaleen Garbage Collectors of Cairo. *Environment & Urbanization*. 17(2):155-170.

Fakunle, S.O. & Ajani, A.O. 2021. An Empirical Study of Community Involvement in Household Solid Waste Management: A Case Study. *Insights into Regional Development*. 3(4):105-118. [http://doi.org/10.9770/IRD.2021.3.3\(7\)](http://doi.org/10.9770/IRD.2021.3.3(7))

Farage, L., Uhl-Haedicke, I. & Hansen, N. 2021. Problem Awareness Does Not Predict Littering: A Field Study on Littering in the Gambia. *Journal of Environmental Psychology*. <https://doi.org/10.1016/j.jenvp.2021.101686>

Fercoq, A., Lamouri, S. & Carbone, V. 2016. Lean/Green Integration Focused on Waste Reduction Techniques. *Journal of Cleaner Production*. 137:567-578.

Fernandez-Haddad, M., Aguirre, A. and Ingram, M. 2021. The Role of *Promotoras* in Community-based Social Marketing: Anti-littering Interventions. *Journal of Social Marketing*. 11(4): 597-615.

Fernando, R. & Lalitha, S. 2019. Solid Waste Management of Local Governments in the Western Province of Sri Lanka: An Implementation Analysis. *Waste Management*. 84:194-203.

Ferrante, M.C., Di Vaio, P., Magli, E., Frecentese, F., Meli R., Caliendo, G., Corvino, A., Fiorino, F. et al. 2020. PCB Levels in Adipose Tissue of Dogs from Illegal Dumping Sites in Campania Region (Italy). *Chemosphere*. 244. <https://doi.org/10.1016/j.chemosphere.2019.125478>

Ferreira, V. & Teixeira, M.R. 2010. Healthcare Waste Management Practices and Risk Perceptions: Findings from Hospitals in the Algarve Region, Portugal. *Waste Management*. 30(12):2657-2663.

Fiksel, J. & Lal, R. 2018. Transforming Waste into Resources for the Indian Economy. *Environmental Development*. 26:123-128.

Filho, W.L., Brandli, L., Moora, H., Kruopiené, J. & Stenmarck, A. 2016. Benchmarking Approaches and Methods in the Field of Urban Waste Management. *Journal of Cleaner Production*. 112(5):4377-4386. <https://doi.org/10.1016/j.jclepro.2015.09.065>

Finnie, W.C. 1973. Field Experiments in Litter Control. *Environment and Behavior*. 5: 123-144.

Foster, S., Dixey, R., Oberlin, A. & Nkhama, E. 2012. 'Sweeping is Women's Work': Employment and Empowerment Opportunities for Women through Engagement in Solid Waste Management in Tanzania and Zambia. *International Journal of Health Promotion and Education*. 50(4):203-217.

Francey, D. & Bergmüller, R. 2012. Images of Eyes Enhance Investments in a Real-life Public Good. *PLoS ONE*. 7(5):e37397. <https://doi.org/10.1371/journal.pone.0037397>

Freije, A.M., Naser, H.A. & Abdulla, K.H. 2019. Attitudes and Opinions Towards Public Littering in the Kingdom of Bahrain. *Arab Journal of Basic and Applied Sciences*. 26(1):354-361. <https://doi.org/10.1080/25765299.2019.1628688>

Fujikura, M. 2011. Japan's Efforts Against the Illegal Dumping of Industrial Waste. *Environmental Policy and Governance*. 21(5):325-337.

Fuldauer, L.I., Ives, M.C., Adshead, D., Thacker, S. & Hall, J.W. 2019. Participatory Planning of the Future of Waste Management in Small Island Developing States to Deliver on the Sustainable Development Goals. *Journal of Cleaner Production*. 223:147-162.

Fullerton, D. & Kinnaman, T.C. 1995. Garbage, recycling and illicit burning or dumping. *Journal of Environmental Economics and Management*. 29:78-91.

Furedy, C. 1992. Garbage: Exploring Non-conventional Options in Asian Cities. *Environment & Urbanization*. 4(2):42-61.

Garg, A.K. & Mashilwane, C. 2015. Waste Disposal Pattern of Mamelodi Township in Tshwane Metropolitan Municipality. *Environmental Economics* 6(2):91-98.

Geller, E.S., Winett, R.A. & Everett, P.B. (eds) 1982. *Preserving the Environment: New Strategies for Behavior Change*. New York: Pergamon

Gentil, E.C., Gallo, D. & Christensen, T.H. 2011. Environmental Evaluation of Municipal Waste Prevention. *Waste Management*. 31(12)2371-2379.

Ghadban, S., Shames, M. & Abou Mayaleh, H. 2017. Trash Crisis and Solid Waste Management in Lebanon – Analyzing Hotels' Commitment and Guests' Preferences. *Journal of Tourism Research & Hospitality*. 6(3).

Ghiani, G., Lagana, D., Manni, E., Musmanno, R. & Vigo, D. 2014. Operations Research in Solid Waste Management: A Survey of Strategic and Tactical Issues. *Computers & Operations Research*. 44:22-32.

Gilbert, E. & Fumba, X. 2011. Cleaning Up the Mother City. *IMIESA*.

Gilli, M., Nicolli, F. & Farinelli, P. 2018. "Behavioural Attitudes Towards Waste Prevention and Recycling" *Ecological Economics*. 154:294-305

Gilpin, A. 1996. *Dictionary of Environment and Development*. Chichester: Wiley.

Godbey, G., Reid, L. & Robinson, J. 1998. No Time to Waste: An Exploration of Time Use, Attitudes toward, Time, and the Generation of Municipal Solid Waste. *Social Research*. 65(1):101-140.

Gonçalves, A.T.T., Moraes, Flávia, T.F., Marques, G.L., Lima, J.P. & da Silva Lima, R. 2018. Urban Solid Waste Challenges in the BRICS countries: A Systematic Literature Review. *Rev. Ambiente & Água - An Interdisciplinary Journal of Applied Science*. 13(2):1-20.

Gorobets, A. 2019. Urban Waste Recycling in Developing Countries Should Be Improved. *Current Science*. 117(2):173-174.

Govender, N. & Reddy, P.S. 2020. An Evaluation of eThekweni Municipality's Regeneration Programmes on Littering and Dumping. *African Evaluation Journal*. 8(1). <https://doi.org/10.4102/aej.v8i1.415>

Gray, W.B. & Shimshack, J.P. 2011. The effectiveness of environmental monitoring and enforcement: A review of empirical evidence. *Review of Environmental Economics and Policy*. 5(1): 3-24.

Gregson, N., Crang, M., Laws, J., Fleetwood, T. & Holmes, H. 2013. Moving up the Waste Hierarchy: Car Boot Sales, Reuse Exchange and the Challenges of Consumer Culture to Waste Prevention. *Resources, Conservation & Recycling*. 77:97-107.

Gunggut, H., Hing, C.K., Saufi, D.S.N.S.A.M. 2013. Internalization and Anti Littering Campaign Implementation. *Procedia - Social and Behavioral Sciences*. 85: 544-553. <https://doi.org/10.1016/j.sbspro.2013.08.383>

Gusmerotti, N.M., Corsini, F., Testa, F., Borghini, A & Iraldo, F. 2016. Predicting behaviours related to marine litter prevention: an empirical case based on junior high school students in Italy. *International Journal of Sustainable Society*. 8 (1): 1-21

Gutberlet, J., Kain, J-H., Nyakinya, B., Oloko, M., Zapata, P. & Zapata Campor, M.J. 2017. Bridging weak links of solid waste management in Informal Settlements. *Journal of Environment and Development*. 26(1):106-131.

Guyot, M., Thomas, I. & Vanwambeke, S.O. 2021. Is Illegal Dumping Associated with Some Urban Designs? Evidence from Fix My Street Data, Brussels. *Proceedings of the XXVIII International Seminar on Urban Form: Urban Form and the Sustainable and Prosperous Cities*. 29 June-3 July 2021. Glasgow.

Han, S., Morçöl, G., Hummer, D. & Peterson, S.A. 2017. The Effects of Business Improvement Districts in Reducing Nuisance Crimes: Evidence from Philadelphia. *Journal of Urban Affairs*. 39(5):658-674.

Hansmann, R., Loukopoulos, P. & Scholz, R.W. 2009. Characteristics of Effective Battery Recycling Slogans: A Swiss Field Study. *Resources, Conservation and Recycling*. 53:218-230.

Hansmann, R. and Steimer, N. 2015. Linking an Integrative Behavior Model to elements of environmental campaigns: An analysis of face-to-face communication and posters against littering. *Sustainability*. 7(6): 6937-6956. <https://doi.org/10.3390/su7066937>

Hartley, B.L, Thompson, R.C. & Pahl, S. 2015. Marine Litter Education Boosts Children's Understanding and Self-reported Actions. *Marine Pollution Bulletin*. 90(1-2): 209-217. <https://doi.org/10.1016/j.marpolbul.2014.10.049>

Hassell, H.J.G. & Wyler, E.E. 2019 Negative Descriptive Social Norms and Political Action: People Aren't Acting, So You Should. *Political Behavior*. 41:231-256.

He, Z., Chu, Z., Zhao, M., Zhuang, J. & Liu, F. 2018. Policy-making Coordination of Municipal Solid Waste Policies in China: A Content Analysis. *Journal of Material Cycles Waste Management*. 20:1037-1084 <https://doi.org/10.1007/s10163-017-0668-3> .

Hernández, O., Rawlins, B. & Schwartz, R. 1999. Voluntary Recycling in Quito: Factors Associated with Participation in a Pilot Programme. *Environment & Urbanization*. 11:145-160.

Hettiarachchi, H., Ryu, S., Caucci, S. & Silva, R. 2018. Municipal Solid Waste Management in Latin America and the Caribbean: Issues and Potential Solutions from the Governance Perspective. *Recycling* 3:19-33.

Hietler, P. & Pladerer, C. 2020. Littering in Österreich als Beitrag für Mikro- und Makro Kunststoffe in der Umwelt (littering in Austria as a contribution to micro and macro plastics in the environment). *Österreichische Wasser- und Abfallwirtschaft*. 72:370-377.

Hilburn, A. 2016. Gauging the Material Magnitude, Public Perception, and Governance of Roadside Litter in a Rural Mexican Municipio. *Human Ecology*. 44: 479-491. <https://doi.org/10.1007/s10745-016-9842-9>

Hinčica, V. 2018. How to Combat Littering – An Analysis with a Focus on the Czech Republic. *Economic and Environmental Studies*. 18(1):147-172.

Hing, C.K. & Gunggut, H. 2012. Maintaining Urban Cleanliness: A New Model. *Procedia – Social and Behavioral Sciences*. 50:950-958.

Hodge, K.L., Levis, J.W., DeCarolis, J.F. & Barlaz, M.A. 2016. Systematic Evaluation of Industrial, Commercial and Institutional Food Waste Management Strategies in the United States. *Environmental Science and Technology*. 50(16):8444-8452.

Hollander, J.B., Pallagst, K.M., Schwarz, T. & Popper, F.J. 2009 Planning Shrinking Cities. *Progress in Planning* 72(4): 223-232.

Hoornweg D & Bhada-Tata P. 2012. What a Waste: A Global Review of Solid Waste Management. *Urban development series; knowledge papers no. 15. World Bank, Washington, DC. World Bank. Available: <https://openknowledge.worldbank.org/handle/10986/17388>*

Horseley, A.D. 1988. The Unintended Effects of a Posted Sign on Littering Attitudes and Stated Intentions. *Journal of Environmental Education*. 19(3): 10-14.

Howell, J.P. 2017. Waste Governance and Ecological Identity in Maui, Hawaii, USA. *Geoforum*. 79:81-89.

Howlett, M. 1991. Policy Instruments, policy styles, and policy implementation : national approaches to theories of instrument choice. *Policies Studies Journal* 19(2): 1-21.

Huffman, K.T., Grossnickle, W.F., Cope, J.G. & Huffman, K.P. 1995. Litter Reduction: A Review and Integration of the Literature. *Environment and Behaviour*. 27(2):153-183.

Hutner, P., Thorenz, A. & Tuma, A. 2017. Waste Prevention in Communities: A Comprehensive Survey Analyzing Status Quo, Potentials, Barriers and Measures. *Journal of Cleaner Production*. 141:837-851.

Ibrahim, M.I.M. & Mohamed, N.A.E.M. 2016. Towards Sustainable Management of Solid Waste in Egypt. *Procedia Environmental Sciences*. 34:336-347.

Ichinose, D. & Yamamoto, M. 2011. On the Relationship Between the Provision of Waste Management Service and Illegal Dumping. *Resource and Energy Economics*. 33:79-93.

Idowu, I.A., Atherton, W., Hashim, K., Kot, P., Alkhaddar, R., Alo, B.I. & Shaw, A. 2019. An Analyses of the Status of Landfill Classification Systems in Developing Countries: Sub Saharan Africa Landfill Experiences. *Waste Management*. 87:761-771.

Idris, M.A.M., Moe, S.S., Yusoh, M.P. & Abas, M.A. 2021. Household preferences for improved municipal solid waste management services in Penang and Terengganu. *Proceedings of the IOP Conference Series: Earth and Environmental Science, 842, 3rd International Conference on Tropical Resources and Sustainable Sciences*. 14-15 July 2021. Kelantan, Malaysia.

Ifegbesan, A.P., Ogunyemi, B. & Rampedi, I.T. 2017. Students' Attitudes to Solid Waste Management in a Nigerian University: Implications of Campus-based Sustainability Education. *International Journal of Sustainability in Higher Education*. 18(7):1244-1262.

Ilic, M. & Nicolich, M. 2016. Waste Management Benchmarking: A Case Study of Serbia. *Habitat International*. 53:453-460.

Indrawati, D. & Purwaningrum, P. 2018. Identification and Analysis: the Illegal Dumping Spot of Solid Waste at Ciliwung Segment 5 Riverbanks. *Proceedings of the IOP Conference Series: Earth and Environmental Science*. 106:1-6.

Inglezakis, V., Moustakas, K., Khamitova, G., Tokmurzin, D., Sarbassov, Y., Rakhmatulina, R., Serik, B., Abikak, Y. & Pouloupoulos, S. 2018. Current Municipal Solid Waste Management in the Cities of Astana and Almaty of Kazakhstan and Evaluation of Alternative Management Scenarios. *Clean Technologies and Environmental Policy*. 20(3):503-516.

iNudgeyou. The Applied Behavioural Science Group. <http://inudgeyou.com/green-nudge-nudging-litter-into-the-bin/>

Ioja, C.L., Onose, D.A., Grădinaru, S.R. & Şerban, C. 2012. Waste Management in Public Educational Institutions of Bucharest City, Romania. *Procedia Environmental Sciences*. 14:71-78.

Ishii, K., Furuichi, T. & Nagao, Y. 2013. A Needs Analysis Method for Land-use Planning of Illegal Dumping Sites: A Case Study in Aomori-Iwate, Japan. *Waste Management*. 33(2)445-455.

Izvercian, M. & Ivascu, L. 2015. Waste Management in the Context of Sustainable Development: Case Study in Romania. *Procedia Economics and Finance*. 26:717-721.

Jaccoud, C. & Magrini, A. 2014. Regulation of Solid Waste Management at Brazilian Ports: Analysis and Proposals for Brazil in Light of the European Experience. *Marine Pollution Bulletin*. 79:245-253.

Jadoon, A., Batool, S.A. & Chaudhry, M.N. 2014. Assessment of Factors Affecting Household Solid Waste Generation and its Composition in Gulberg Town, Lahore, Pakistan. *Journal of Material Cycles Waste Management*. 16:73–81.

Jakiel, M., Bernatek-Jakiel, A., Gajda, A., Filiks, M. & Pufelska, M. 2019. Spatial and Temporal Distribution of Illegal Dumping Sites in the Nature Protected Area: The Ojcow National Park, Poland. *Journal of Environmental Planning and Management*. 62(2).

Jambeck, J., Hardesty, B.D., Brooks, A.L., Friend, T., Teleki, K., Fabres, J., Beaudoin, Y., Bamba, A. et al. 2018. Challenges and Emerging Solutions to the Land-based Plastic Waste Issue in Africa. *Marine Policy*. 96:256-263.

Jerie, S. 2016. Occupational Risks Associated with Solid Waste Management in the Informal Sector of Gweru, Zimbabwe. *Journal of Environmental and Public Health*. 1-14.

Jewaskiewitz, S. 2011. Overview of Waste Management in South Africa. *IMIESA*. 39-41.

Johansson, N. & Corvellec, H. 2018. Waste Policies Gone Soft: An Analysis of European and Swedish Waste Prevention Plans. *Waste Management*. 77:322-332.

Johnson, R.J. & Scicchitano, M.J. 2012. Don't Call Me NIMBY: Public Attitudes toward Solid Waste Facilities. *Environment and Behavior*. 44(3):410-426.

Jones, N., Evangelinos, K., Halvadakis, C.P., Iosifides, T. & Sophoulis, C.M. 2010. Social Factors Influencing Perceptions and Willingness to Pay for a Market-based Policy Aiming on Solid Waste Management. *Resources, Conservation and Recycling*. 54(9):533-540.

Joo, Y. & Kwon, Y. 2015. Urban Street Greenery as a Prevention against Illegal Dumping of Household Garbage – A Case in Suwon, South Korea. *Urban Forestry & Urban Greening*. 14:1088-1094.

Joseph, K., Rajendiran, S., Senthilnathan, R. & Rakesh, M. 2012. Integrated Approach to Solid Waste Management in Chennai: An Indian Metro City. (2012) 14 *Journal of Material Cycles Waste Management*. 14:75-84.

Joshi, R. & Ahmed, S. 2016. Status and Challenges of Municipal Solid Waste Management in India: A Review. *Cogent Environmental Science*. 2:1-18.

Kain, J-H., Nyakinya, B., Odhiambo, N., Oloko, M., Olomo, J., Otieno, S., Zapata, P., Zapata, C. & María, J. 2016. Translating Policies into Informal Settlements' Critical Services: Reframing, Anchoring and Muddling Through. *Public Administration and Development*. 36(5)330-346.

Kamaruddin, S.M., Pawson, E. & Kingham, S. 2013. Facilitating Social Learning in Sustainable Waste Management: Case Study of NGOs Involvement in Selangor Malaysia. *Procedia – Social and Behavioral Sciences*. 105:325-332.

Kandil, S.H., Bakr, H.A. & Mortensen, L. 2004. Incorporating Environmental Awareness of Solid Waste Management within the Education System (A Case from Egypt). *Polymer-Plastics Technology and Engineering*. 43(6)1795-1803.

Kang, Y.H. 1999. Willingness to Participate in Curbside Recycling Program. *International Review of Public Administration*. 81-89.

Karbalaei, S., Abdollahi, A., Talib, M.A., Yaacob, S.N. & Ismail, Z. 2013. Locus of Control, Problem-solving Skills, Appraisal as Predictors of Waste Prevention Behaviours. *Romanian Journal of Applied Psychology*. 15(2):51-58.

Karout, N. & Altuwaijri, S. 2012. Impact of Health Education on Community Knowledge, Attitudes and Behaviour towards Solid Waste Management in Al Ghobeiry, Beirut. *Eastern Mediterranean Health Journal*. 18(7):777-785.

Katusiimeh, M.W., Mol, A.P.J. & Burger, K. 2012. The Operations and Effectiveness of Public and Private Provision of Solid Waste Collection Services in Kampala. *Habitat International*. 36(2):247-252.

Katusiimeh, M.W. & Mol A.P.J. 2011. Environmental Legacies of Major Events: Solid Waste Management and the Commonwealth Heads of Government Meeting (CHOGM) in Uganda. *African Studies Quarterly*. 12(3):47-65.

Keep Scotland Beautiful and Institute for Social Marketing, University of Sterling *Report Nudge Study Implementation Toolkit: Promoting the Use of Street Litter Bins* (2015) <http://inudgeyou.com/green-nudge-nudging-litter-into-the-bin>).

Keyter, C. 2010. Perceptions of Stakeholders Involved in a Public-Private Partnership Arrangement: A Case Study of Solid Waste Management in the City of Windhoek, Namibia. *Journal of Public Administration*. 45(1):18-29.

Khalil, J.F. 2017. Lebanon's Waste Crisis: An Exercise of Participation Rights. *New Media & Society*. 19(5):701-712.

Khan, I.N.G. 2020. The New Norms for Household Solid Waste Management in Time of COVID-19: Malaysian Legal Perspective. *Proceedings of the International Seminar on Syariah and Law (INSLA) E-Proceedings*. 3(1):660-668.

Khan, D., Kumar, A. & Samadder, S.R. 2016. Impact of Socioeconomic Status on Municipal Solid Waste Generation Rate. *Waste Management*. 49:15-25.

Khandelwal, H., Dhar, H., Thalla, A.K. & Kumar, S. 2019. Application of Life Cycle Assessment in Municipal Solid Waste Management: A Worldwide Critical Review. *Journal of Cleaner Production*. 209:630-654.

Khawaja F.S. & Shah A. 2013. Determinants of Littering: An Experimental Analysis. *The Pakistan Development Review*. 52(2):157-168.

Kim, G-S., Chang, Y-J. & Kelleher, D. 2008. Unit Pricing of Municipal Solid Waste and Illegal Dumping: An Empirical Analysis of Korean Experience. *Environmental Economics and Policy Studies*. 9:167-176.

Kim, S-J. 2002. Korean Waste Management and Eco-efficient Symbiosis – A Case Study of Kwangmyong City. *Clean Technologies and Environmental Policy*. 3(4):371-382.

Kirkman, R. & Voulvoulis, N. 2017. The Role of Public Communication in Decision Making for Waste Management Infrastructure. *Journal of Environmental Management*. 203:640-647.

Kitila, A.W. & Woldemikael, S.M. 2019. Waste Electrical and Electronic Equipment Management in the Educational Institutions and Governmental Sector Offices of Addis Ababa, Ethiopia. *Waste Management*. 85:30-41.

Knutsson, S.G., Asplund, T., Höst, G. & Schönborn, J. 2021. Public Perceptions of Waste Management in Sri Lanka: A Focus Group Study. *Sustainability*. 13(23):1-17. <https://doi.org/10.3390/su132312960>

Kodua, T.T. and Anaman, K.A. 2020. Indiscriminate Open Space Solid Waste Dumping Behaviour of Householders in the Brong-Ahafo Region of Ghana: A Political Economy Analysis. *Cogent Environmental Science*. 6(1). <http://dx.doi.org/10.1080/23311843.2020.1779553>

Kolenda, K., Wiśniewski, K., Krzysztof, K., Kuśmierk, N., Smolis, A. & Kadej, M. 2021. Living in Discarded Containers: Spiders Explore a New Niche Created by Littering in Urban Woodlands. *Biodiversity and Conservation*. 30:1637-1654.

Kolikkathara, N., Feng, H. & Stern E. 2009. A Purview of Waste Management Evolution: Special Emphasis on USA. *Waste Management*. 29:974-985.

Kraidy, M.M. 2016. Trashing the Sectarian System? Lebanon's 'You Stink' Movement and the Making of Affective Publics. *Communication and the Public*. 1(1)19-26.

Kreith F. 1994. *Handbook of Municipal Solid Waste Management*. New York: McGraw-Hill.

Krelling, A.P., Williams, A.T. & Turra, A. 2017. Differences in Perception and Reaction of Tourist Groups to Beach Marine Debris that can Influence a Loss of Tourism Revenue in Coastal Areas. *Marine Policy*. 85: 87-99. <http://dx.doi.org/10.1016/j.marpol.2017.08.021>

Kubanza, N.S., Das, D.K. & Simatele, D. 2017. Some Happy, Others Sad: Exploring Environmental Justice in Solid Waste Management in Kinshasa, The Democratic Republic of Congo. *The International Journal of Justice and Sustainability*. 22(5):595-620.

Kubanza, N.S. & 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, <https://doi.org/10.1080/09640568.2019.1576510>.

Kubanza, N.S. & Simatele, D. 2018. Sustainable Solid Waste Management in Sub-Saharan African Cities: Application of System Thinking and System Dynamic as Methodological Imperatives in Kinshasa, the Democratic Republic of Congo. *Local Environment*. 23(2):220-238.

Kubanza, N.S. & Simatele, D. 2016. Social and Environmental Injustices in Solid Waste Management in sub-Saharan Africa: A Study of Kinshasa, The Democratic Republic of Congo. *Local Environment*. 21(7):866-882.

Kulatunga, U., Amaratunga, D., Haigh, R. & Rameezdeen, R. 2006. Attitudes and Perceptions of Construction Workforce on Construction Waste in Sri Lanka. *Management of Environmental Quality*. 17(1)57-72.

Kuniyal, J.C., Jain, A.P. & Shannigrahi, A.S. 1998. Public Involvement in Solid Waste Management in Himalayan Trails in and around the Valley of Flowers, India *Resources, Conservation & Recycling*. 24(3):299-322.

Kuyateh, M. and Cham, B.B. 2019. Addressing Indiscriminate Dumping of Waste for Concern Authorities in The Gambia. Proposal Paper: Environmental Project Aimed at Addressing Indiscriminate Dumping of Waste for Concern Authorities in The Gambia. School of Public Health, The Gambia College.

Kwailane, T.T., Gwebu, T.D. & Hambira, W.L. 2016. Challenges of Domestic Solid Waste Management: A Case Study of Lobatse Botswana. *African Geographical Review*. 35(2)117-133.

Kwenda, P.R., Lagerwall, G., Eker, S. & Van Ruijven, B. 2022. A Mini-review on Household Solid Waste Management Systems in Low-income Developing Countries: A Case Study of Urban Harare City, Zimbabwe. *Waste Management & Research*. 40(2)139-153.

LaGrange, R. L., Ferraro, K. F., & Supancic, M. 1992. Perceived Risk and Fear of Crime: Role of Social and Physical Incivilities. *Journal of Research in Crime and Delinquency*. 29(3): 311-334. <http://doi.org/10.1177/0022427892029003004>

Lambrechts, D. & Hector, M. 2016. Environmental Organised Crime: The Dirty Business of Hazardous Waste Disposal and Limited State Capacity in Africa. *Politikon: South African Journal of Political Studies*. 43(2)251-268.

Langenhoven, B. & Dyssel, M. 2007. The Recycling Industry and Subsistence Waste Collectors: A Case Study of Mitchell's Plain. *Urban Forum* 18(1):114-132.

Lasaridi, K., Hatzi, O., Batistatos, G., Konstadinos, A., Chroni, C., Kalogeropoulos, N., Chatzieleftheriou, C., Gargoulas, N. et al. 2015. Waste Prevention Scenarios Using a Web-based Tool for Local Authorities. *Waste Biomass Valorization*. 6(5):625-636.

Latif, S.A., Omar, M.S., Bidin, Y.H. & Awang, Z. 2013. Role of Environmental Knowledge in Creating Pro-environmental Residents. *Procedia - Social and Behavioral Sciences*. 105: 866-874. <https://doi.org/10.1016/j.sbspro.2013.11.088>

Laxamana, R. 2019. *San Jose's Removing and Preventing Illegal Dumping Program (RAPID): An Evaluation of Illegal Dumping in San Jose*. Masters Thesis. Public Administration, San Jose State University.

Leal, F.W., Brandli, L., Moora, H., Kruopiene, J. & Stenmarck, A. 2016. Benchmarking Approaches and Methods in the Field of Urban Waste Management. *Journal of Cleaner Production*. 112:4377-4386.

Lega, M., Ferrara, C., Persechino, G. & Bishop, P. 2014. Remote Sensing in Environmental Police Investigations: Aerial Platforms and an Innovative Application of Thermography to Detect Several Illegal Activities. *Environmental Monitoring and Assessment*. 186:8291-8301.

Leton, T. & Omotosho, O. 2004. Landfill Operations in the Niger Delta Region of Nigeria. *Engineering Geology*. 73:171-177.

Lighthall, D.R. & Kopecky, S. 2000. Confronting the Problem of Backyard Burning: The Case for a National Ban. *Society & Natural Resources*. 13(2):157-167.

Lin, M-D., Wang, C. & Lin, C. 2006. Evaluation of Solid Waste Management Strategies in the Taipei Metropolitan Area of Taiwan. *Journal of the Air & Waste Management Association*. 56(5):650-656.

Linder, S.H., & Peters, B.G. 1989. Instruments of government : Perceptions and contexts. *Journal of Public Policy*. 9(1): 35–58.
<https://ojs.unbc.ca/index.php/design/article/viewFile/1482/1224>

Lingard, H., Graham, P. & Smithers, G. 2000. Employee Perceptions of the Solid Waste Management System Operating in a Large Australian Contracting Organization: Implications for Company Policy Implementation. *Construction Management & Economics*. 18:383-393.

Liu, C., Hua, C. & Chen, J. 2021. Efficient Supervision Strategy for Illegal Dumping of Construction and Demolition Waste: A Networked Game Theory Decision-making Model. *Waste Management and Research*. 1-11.
<https://doi.org/10.1177%2F0734242X211032031>

Liu, Y., Kong, F. & Santibanez Gonzalez, E.D.R. 2017. Dumping, Waste Management and Ecological Security: Evidence from England. *Journal of Cleaner Production*. 167:1425-1437.

Liu, J., Li, Q., Gu, W. & Wang, C. 2019. The Impact of Consumption Patterns on the Generation of Municipal Solid Waste in China: Evidences from Provincial Data. *International Journal of Environment Research and Public Health*. 16(10):1717–1736.
<https://doi.org/10.3390/ijerph16101717>

Loukil, F. & Rouached, L. 2012. Modeling Packaging Waste Policy Instruments and Recycling in the MENA region. *Resources, Conservation & Recycling*. 69:141-152.

Lu, W. 2019. Big Data Analytics to Identify Illegal Construction Waste Dumping: A Hong Kong Study. *Resources, Conservation & Recycling*. 141:264-272.

Luthra, A. 2018. 'Old Habits Die Hard': Discourses of Urban Filth in *Swachh Bharat Mission* and *The Ugly Indian*. *Journal of Multicultural Discourses*. 13(2): 120-138.
<https://doi.org/10.1080/17447143.2018.1467917>

Luton, L.S. 1995. Citizen Participation in Solid Waste Policymaking: A Case Study of the Spokane Experience [Abstract]. *International Journal of Public Administration*. 18(4):613-637.

Lutringer, C. & Randeria, S. 2017. How not to Waste a Garbage Crisis: Food Consumption, Solid Waste Management and Civic Activism in Bangalore/Bengaluru, India. *Revue Internationale de Politique de Développement*.

Ma, J. & Hipel, K.W. 2016. Exploring Social Dimensions of Municipal Solid Waste Management Around the Globe - A Systematic Literature Review. *Waste Management*. 56:3-12. <https://doi.org/10.1016/j.wasman.2016.06.041>

Ma, J., Hipel, K.W. & Hanson, M.L. 2018. An Evaluation of the Social Dimensions in Public Participation in Rural Domestic Waste Source-separated Collection in Guilin, China. *Environmental Monitoring and Assessment*. 190(35):1-14. <https://doi.org/10.1007/s10661-017-6405-5>

Ma, R., Cai, B. & Tan, X. 2020. Research and Application of Solid Waste Dumping Calculation Method in Criminal Cases of Environmental Pollution Caused by Illegal Dumping of Solid Waste Based on Arcgis. Proceedings of the Third International Workshop on Environment and Geoscience IOP Conference Series: Earth and Environmental Science. doi:10.1088/1755-1315/569/1/012057

Malinauskaite, J., Jouhara, H., Czajczyńska, D., Stanchev, P., Katsou, E., Rostkowski, P., Thorne, R.J., Ponsa, S. et al. 2017. Municipal Solid Waste Management and Waste-to-Energy in the Context of a Circular Economy and Energy Recycling in Europe. *Energy*. 141:2013–2044.

Malomo, B.I., Akinbode, G.A. & Olatimehin, V.O. 2021. Assessment of the broken windows theory and littering behaviour among students in a Nigerian university: Implication on post COVID-19 classroom littering. *Ethiopian Journal of Environmental Studies and Management*. 14(6):766-775.

Mamady, K. 2016. Factors Influencing Attitude, Safety Behavior, and Knowledge regarding Household Waste Management in Guinea: A Cross-Sectional Study. *Journal of Environmental and Public Health*. 1-9.

Manomaivibool, P. 2015. Wasteful Tourism in Developing Economy? A Present Situation and Sustainable Scenarios. *Resources, Conservation and Recycling*. 103:69-76. <https://doi.org/10.1016/j.resconrec.2015.07.020>

Martinez, C.A. & Bowen, J.D. 2012. The Clean Development Mechanism in the Solid Waste Management Sector: Sustainable for Whom? *Ecological Economics*. 82:123-125.

Maritinez-Sanchez, V., Levis, J.W., Damgaard, A., DeCarolis, J.F., Barlaz, M.A. & Astrup, T.F. 2017. Evaluation of Externality Costs in Life-Cycle Optimization of Municipal Solid Waste Management Systems. *Environmental Science & Technology*. 51(6):3119-3127.

Maritinez-Sanchez, V., Tonini, D., Moller, F. & Astrup, T.F. 2016. Life-Cycle Costing of Food Waste Management in Denmark: Importance of Indirect Effects. *Environmental Science & Technology*. 50(8):4513-4523.

Marshall, R.E. & Farahbakhsh, K. 2013. Systems Approaches to Integrated Solid Waste Management in Developing Countries. *Waste Management*. 33(4):988-1003.

Matsekoleng, T.K. 2021. Action Research and Environmental Education Within a Home-based Setup to Conscientise Children Towards Littering. *Environment, Development and Sustainability*. 23:14163-14175. <https://doi.org/10.1007/s10668-021-01251-0>

Matsekoleng, T.K. & Awshar, M.T. 2020. Improved Attitudes Towards Littering Through Progressive Action Research Activities in an Environmental Education Context. *Asia-Pacific Journal of Teacher Education*. <https://doi.org/10.1080/1359866X.2020.1793906>

Matsuda, T., Hirai, Y., Asari, M., Yano, J., Miura, T., Ii, R. & Sakai, S-I. 2018. Monitoring Environmental Burden Reduction from Household Waste Prevention. *Waste Management*. 71:2-9.

Matsumoto, S. & Takeuchi, K. 2011. The Effect of Community Characteristics on the Frequency of Illegal Dumping. *Environmental Economics and Policy Studies*. 13:177-193.

Matter, A., Dietschi, M. & Zurbrügg, C. 2013. Improving the Informal Recycling Sector through Segregation of Waste in the Household – the Case of Dhaka Bangladesh. *Habitat International*. 38:150-156.

Mbah, P.P. & Nzeadibe, T.C. 2017. Inclusive Municipal Solid Waste Management Policy in Nigeria: Engaging the Informal Economy in post-2015 Development Agenda. *Local Environment*. 22(2):203-224.

Mbuligwe, S.E., Kassenga, G.R., Kaseva, M.E. & Chaggu, E.J. 2002. Potential and Constraints of Composting Domestic Solid Waste in Developing Countries: Findings from a Pilot Study in Dar Es Salaam, Tanzania. *Resources, Conservation & Recycling*. 36(1):45-59.

McKercher, B. & Weber, K. 2008. Rationalising Inappropriate Behaviour at Contested Sites. *Journal of Sustainable Tourism*. 16(4):369–385.

Medina, M. 2000. Scavenger Cooperatives in Asia and Latin America. *Resources, Conservation & Recycling*. 31(1):51-69

Meloni, A., Fornara, F. & Carrus, G. 2019. Predicting Pro-environmental Behaviors in the Urban Context: The Direct or Moderated Effect of Urban Stress, City Identity, and Worldviews. *Cities*. 88: 83-90. <https://doi.org/10.1016/j.cities.2019.01.001>

Mihai, F-C. 2019. Construction and Demolition Waste in Romania: The Route from Illegal Dumping to Building Materials. *Sustainability*. 11(11). <https://doi.org/10.3390/su11113179>

Mihai, F-C. & Ingrao, C. 2018. Assessment of Biowaste Losses through Unsound Waste Management Practices in Rural Areas and the Role of Home Composting. *Journal of Cleaner Production*. 172:1631-1638.

Millington, N. & Lawhon, M. 2018. Geographies of Waste: Conceptual Vectors from the Global South. *Progress in Human Geography*. 20(10):1-20.

Miraftab, F. 2004. Neoliberalism and Casualization of Public Sector Services: The Case of Waste Collection Services in Cape Town, South Africa. *International Journal of Urban and Regional Research*. 28(4):874-892.

Mmerekhi, D. 2018. Current Status of Waste Management in Botswana: A Mini-review. *Waste Management & Research*. 36(7):555-576.

Mmerekhi, D., Baldwin, A. & Li, B. 2016. A Comparative Analysis of Solid Waste Management in Developed, Developing and Lesser Developed Countries. *Environmental Technology Reviews*. 5(1):120-141.

Mohajerani, A., Hui, S.Q., Shen, C., Suntovski, J., Rodwell, G., Kurmus, H., Hana, M. & Rahman, M.T.R. 2020. Implementation of Recycling Cigarette Butts in Lightweight Bricks and a Proposal for Ending the Littering of Cigarette Butts in Our Cities. *Materials*. 13. <https://doi.org/10.3390/ma13184023>

Mohan, G., Sinha, U.K. & Lal, M. 2016. Managing of Solid Waste through Public Private Partnership Model. *Procedia Environmental Sciences*. 35:158-168.

Mohee, R. & Bundhoo, A.Z. 2015. A Comparative Analysis of Solid Waste Management in Developed and Developing Countries. In *Future Directions of Municipal Solid Waste Management in Africa*. Mohee, R. & Simelane, T. (eds). Pretoria: Africa Institute of South Africa.

Momoh, J.J. & Oladebeye, D.H. 2010. Assessment of Awareness, Attitude and Willingness of People to Participate in Household Solid Waste Recycling Programme in Ado-Ekiti, Nigeria. *Journal of Applied Sciences in Environmental Sanitation*. 5(1):93-105.

Moqbel, S., El-tah, Z. & Haddad, A. 2019. Littering in developing countries: The case of Jordan. *Polish Journal of Environmental Studies*. 28(5):3819-3827. <https://doi.org/10.15244/pjoes/94811>

Morgan, J.C., Jeong, M, Mendel-Sheldon, J, Noar, S.M., Ribisl, K.M. & Brewer, N.T. 2021. The Impact of Cigarette Pack Anti-littering Messages. *Addictive Behaviors. An International Journal*. 126 <https://doi.org/10.1016/j.addbeh.2021.107184>

Morlok, J., Schoenberger, H., Styles, D., Galvez-Martos, J-L. & Zeschmar-Lahl, B. 2017. The Impact of Pay-As-You-Throw Schemes on Municipal Solid Waste Management: The Exemplar Case of the County of Aschaffenburg, Germany. *Resources*. 6(8):1-16.

Mozo-Reyes, E., Jambeck, J., Reeves, P. & Johnsen, K. 2016. Will They Recycle? Design and Implementation of Eco-Feedback Technology to Promote On-the-go Recycling in a University Environment. *Resources, Conservation & Recycling*. 114:72-79.

Muñoz-Cadena, C.E., Lina-Manjarrez, P., Estrada-Izquierdo, I. & Ramón-Gallegos, E. 2012. An Approach to Litter Generation and Littering Practices in a Mexico City Neighborhood. *Sustainability*. 4:1733-1754. doi:10.3390/su4081733

Murad, Md. W. & Siwar, C. 2004. Factors Influencing Environmental Behavior of the Urban Poor Concerning Solid Waste Management. *Journal of Environmental Systems*. 31(3):257-277.

Muzenda E, Belaid M and Nkosi N 2019. Illegal Dumping Challenges in West Rand District Municipalities (WRDM), South Africa. Conference Proceedings Fifth International Conference on Energy, Materials, Applied Energetics and Pollution (ICEMAEP2019), October 2019.

Mwanthi, M.A. & Nyabola, L.O. 1997. Solid Waste Management in Nairobi City: Knowledge and Attitudes. *Journal of Environmental Health*. 60(5):23-29.

Mwanza, B.G., Mbohwa, C. & Telukdarie, A. 2018a. The Influence of Waste Collection Systems on Resource Recovery: A Review. *Procedia Manufacturing*. 21:846-853.

Mwanza, B.G., Mbohwa, C. & Telukdarie, A. 2018b. Levers Influencing Sustainable Waste Recovery at Households Level: A Review. *Procedia Manufacturing*. 21:615-622.

Nagatsu, M. 2015. Social Nudges: Their Mechanisms and Justification. *Review of Philosophy and Psychology*. 6(3):481-494.

Nagpure, A.S. 2019. Assessment of Quantity and Composition of Illegal Dumped Municipal Solid Waste (MSW) in Delhi. *Resources, Conservation & Recycling*. 141:54-60.

Nahman A. & Godfrey L. 2010. Economic Instruments for Solid Waste Management in South Africa: Opportunities and Constraints. *Resources, Conservation & Recycling*. 54(8):521-531.

Narduzzi, S., Fantini, F., Blasetti, F., Rantakokko, P., Kiviranta, H., Forastiere, F., Michelozzi, P. and Porta, D. 2020. Predictors of Beta-Hexachlorocyclohexane Blood Levels Among People Living Close to a Chemical Plant and an Illegal Dumping Site. *Environmental Health*. 19(9). <https://doi.org/10.1186/s12940-020-0562-7>

Nasrabadi, T., Hoveidi, H., Bidhendi, G.N., Yavar, A.R. and Mohammadnejad, S. 2008. Evaluating citizen attitudes and participation in solid waste management in Tehran, Iran. *Journal of Environmental Health*. 71(5):30-33.

Navarro, J., Grémillet, D., Afán, I., Ramírez, F., Bouten, W. & Forero, M.G. 2016. Feathered Detectives: Real-Time GPS Tracking of Scavenging Gulls Pinpoints Illegal Waste Dumping. *PLoS ONE*. 11(7):1-9.

Ndau, H. & Tilley, E. 2018. Willingness to Pay for Improved Household Solid Waste Collection in Blantyre, Malawi. *Economies*. 6(4):54.

Nessi, S., Rigamonti, L. & Grosso, M. 2013. Discussion on Methods to Include Prevention Activities in Waste Management LCA. *International Journal of Life Cycle Assessment*. 18:1358-1373.

Nessi, S., Rigamonti, L. & Grosso, M. 2014. Waste Prevention in Liquid Detergent Distribution: A Comparison Based on Life Cycle Assessment. *Science of the Total Environment*. 499:373-383.

Ngbolua, K., Gbatea, A.K., Gamo, A.N., Djolu, R.D., Masengo, C.A. and Bongo, G.N. 2019. Management and Sanitation Measures on Solid Household Waste: A Threat to Gbadolite Municipality, Nord-Ubangi, DRC. *Journal of Environmental Protection and Sustainable Development*. 5(3):88-95.

Nguyen, T.T.P., Zhu, D. & Le, N.P. 2015. Factors Influencing Waste Separation Intention of Residential Households in a Developing Country: Evidence from Hanoi, Vietnam. *Habitat International*. 48:169-176. <https://doi.org/10.1016/j.habitatint.2015.03.013>

Nixon, H. & Saphores, J.M. 2009. Information and the decision to recycle: results from a survey of US households. *Journal of Environmental Planning and Management*. 257–277.

Niyobuhungiro, R.V. & Schenck, C.J. 2021. The dynamics of indiscriminate/illegal dumping of waste in Fisantekraal, Cape Town, South Africa. *Journal of Environmental Management*. 293(1):112954. <https://doi.org/10.1016/j.jenvman.2021.112954>

Niyobuhungiro, R.V. & Schenck, C.J. 2020. A Global Literature Review of the Drivers of Indiscriminate Dumping of Waste: Guiding Future Research in South Africa. *Development Southern Africa*. 321-337. <https://doi.org/10.1080/0376835X.2020.1854086>

Njeru, J. 2006. The Urban Political Ecology of Plastic Bag Waste Problem in Nairobi, Kenya. *Geoforum*. 37(6):1046-1058. <https://doi.org/10.1016/j.geoforum.2006.03.003>

Nkum, R., Ampadu-Ameyaw, R., Antwi, B.Y. & Anderson, K.A. 2021. Household Solid Waste Management in La-Nkwantanang-Madina Municipality of the Greater Accra Region, Ghana. *Journal of Environmental Studies*. 24:1-14.

Noah, M. 2002. An Investigation into the Environmental Impact of the Taxi Industry in Butterworth. *Proceedings of the 21st Annual South African Transport Conference “Towards Building Capacity and Accelerating Delivery*. 15-18 July 2002. Pretoria, South Africa.

Norrgrén, L. & Swahnberg, H. 2016. Investigating Prosocial Behavior: A Case Study of Littering in Laos. Master's Thesis. Department of Management and Engineering, Linköping University.

Noufal, M., Yuanyuan, L., Maalla, Z. & Adipah, S. 2020. Determinants of Household Solid Waste Generation and Composition in Homs City, Syria. *Journal of Environmental and Public Health*. 1-15. <https://doi.org/10.1155/2020/7460356>

Nsimbe, P., Mendoza, H., Wafula, S.T. & Ndejjo, R. 2018. Factors Associated with Composting of Solid Waste at Household Level in Masaka Municipality, Central Uganda. *Journal of Environmental and Public Health*. 1-7. <https://doi.org/10.1155/2018/1284234>

Nwafor, M.C., Igbokwe, J.C., Ali, A.A. & Onoh, C.C. 2019. Level of awareness and information needs on indiscriminate dumping of solid waste among staff and students of Nigerian Universities. *Library Philosophy and Practice (e-journal)*. <https://digitalcommons.unl.edu/libphilprac/2248>

Nyamwange, M. 1996. Public Perception of Strategies for Increasing Participation in Recycling Programs [Abstract]. *The Journal of Environmental Education*. 27(4):19-22.

Nzeadibe, T.C. 2009. Solid Waste Reforms and Informal Recycling in Enugu Urban Area, Nigeria. *Habitat International*. 33(1):93-99.

Nzeadibe, T. & Ajaero, C. 2011. Development Impact of Advocacy Initiatives in Solid Waste Management in Nigeria. *Environment, Development and Sustainability*. 13(1):163-177.

Nzeadibe, T.C. & Anyadike, R.N.C. 2012. Social Participation in City Governance and Urban Livelihoods: Constraints to the Informal Recycling Economy in Aba, Nigeria. *City, Culture and Society*. 3:313-325.

Nzeadibe, T., Anyadike, R. & Njoku-Tony, R. 2012. A Mixed Methods Approach to Vulnerability and Quality of Life Assessment of Waste Picking in Urban Nigeria. *Applied Research in Quality of Life*. 7(4):351-370.

Nzeadibe, T.C. & Mbah, P.O. 2015. Beyond Urban Vulnerability: Interrogating the Social Sustainability of a livelihood in the Informal Economy of Nigerian Cities. *Review of African Political Economy*. 1-20.

O'Brien, J. & Thondhlana, G. 2019. Plastic Bag Use in South Africa: Perceptions, Practices and Potential Intervention Strategies. *Waste Management*. 84(1):320-328.

Oelofse, S.H.H. & Marx Pienaar, N. 2016. Household Food Wastage – A Case Study of Middle to High Income Urban Households in the City of Tshwane. *Proceedings of the 23rd WasteCon Conference*. 17-21 October 2016. Johannesburg, South Africa.

Oelofse, S., Muswema, A. & Ramukhwatho, F. 2018. Household Food Waste Disposal in South Africa: A Case Study of Johannesburg and Ekurhuleni. *South African Journal of Science*. 114(5/6):1-6.

Oguntoyinbo, O.O. 2012. Informal Waste Management System in Nigeria and Barriers to an Inclusive Modern Waste Management System: A Review. *Public Health*. 126(5):441-447.

Ogwuche, J., & Yusufu, A.F. 2011. Assessment of the Factors Influencing the Generation and Disposal of Urban Household Solid Waste in Africa: The Nigerian Perspective Department of Geography, Benue State University, Makurdi. *Journal of Environmental Sciences and Resource Management* 3. (This source is most probably the correct source referenced in several sources including the one drawing on it as Senkwe and Nwale 2001. *Assessment of the Factors Influencing the Generation and Disposal of Urban Household*

Solid Waste in Africa: The Nigerian Perspective)

Ohakwe, J., Nnorom, I.C. & Nwosu, C. 2011. Statistical Modelling of Residents' Concerns towards Solid Waste Management Facility: A Case Study of Three Towns in Southeastern Nigeria. *Continental J. Environmental Design and Management*. 1(1):9-21.

Ojedokun, O. 2011. Attitude Towards Littering as a Mediator of the Relationship between Personality Attributes and Responsible Environmental Behavior. *Waste Management*. 31(12): 2601-2611. <http://dx.doi.org/10.1016/j.wasman.2011.08.014>

Ojedokun, O. 2015. The Littering Attitude Scale (LAS). Development and Structural Validation Using Data from an Indigenous (Nigerian) Sample. *Management of Environmental Quality: An International Journal*. 26(4): 552-565. <https://doi.org/10.1108/MEQ-12-2014-0175>

Ojedokun, O. and Balogun, S.K. 2011. Psycho-sociocultural Analysis of Attitude towards Littering in a Nigerian Urban City. *Ethiopian Journal of Environmental Studies and Management*. 4(1): 68-80. <http://dx.doi.org/10.4314/ejesm.v4i1.9>

Okot-Okumu, J. 2012. Solid Waste Management in African Cities – East Africa. In *Waste Management – An Integrated Vision*. L. F. Marmolejo Rebellon (ed). <https://doi.org/10.5772/50241>

Okot-Okumu, J. & Nyenje, R. 2011. Municipal Solid Waste Management under Decentralisation in Uganda. *Habitat International*. 35(4):537-543.

Oleabhielle, E.J. & Dotimi, D.E. 2020. Indiscriminate Refuse Dumping and Flooding in Amassoma Community, Nigeria. *African Journal of Health, Safety and Environment*. 1(1):11-21. <https://doi.org/10.52417/ajhse.v1i1.28>

Oliva, M., De Marchi, L., Cuccaro, A. & Pretti, C. 2021. Bioassay-based ecotoxicological investigation on marine and freshwater impact of cigarette butt littering. *Environmental Pollution*. 288. <https://doi.org/10.1016/j.envpol.2021.117787>

Olukoju, A. 2018. 'Filthy Rich' and 'Dirt Poor': Social and Cultural Dimensions of Solid Waste Management (SWM) in Lagos. *Social Dynamics*. 44(1):88-106.

Omer, M.A. 2021. Effect of Household Solid Waste Management on Environmental Sanitation in Hargeisa Somaliland. *International Journal of Environmental Protection and Policy*. 9(2):27-32. doi: 10.11648/j.ijep.20210902.12

O'Neill, G.W., Blanck, L.S. & Joyner, M.A. 1980. The Use of Stimulus Control over Littering in a Natural Setting. *Journal of Applied Behavior Analysis*. 13(2): 379-381.

Ong, I.B.L. & Sovacool, B.K. 2012. A Comparative Study of Littering and Waste in Singapore and Japan. *Resources, Conservation and Recycling*. 61:35-42. doi:10.1016/j.resconrec.2011.12.008

Onoda, M. 2012. On Second-best Policing Effort against the Illegal Disposal of Recyclable Waste. *Environmental Economics and Policy Studies*. 14(2):171-188.

Oskamp, S., Harrington, M., Edwards, T., Sherwood, D., Okuda, S. & Swanson, D. 1991. Factors influencing household recycling behavior. *Journal of Environmental Behavior*. 23(4)494-519.

Otai, J. 2020. Assessing household willingness to pay for solid waste management services in Uganda using contingent valuation. MSc Thesis. Environmental and Business Management, Bangor University.

Otwong, A., Jongmeewasin, S. & Phenrat, T. 2021. Legal Obstacles for the Circular Economy in Thailand: Illegal Dumping of Recyclable Hazardous Industrial Waste. *Journal of Cleaner Production*. 302. <https://doi.org/10.1016/j.jclepro.2021.126969>

Owusu, V., Ajei-Addo, E. & Sundberg, C. 2013. Do Economic Incentives Affect Attitudes to Solid Waste Source Separation? Evidence from Ghana. *Resources, Conservation & Recycling*. 78:115-123.

Oyedotun, T.D.T., Kasim, O.F., Famewo, A., Oyedotun, T.D., Moonsammy, S., Ally, N. & Renn-Moonsammy, D-M. 2020. Municipal Waste Management in the Era of COVID-19: Perceptions, Practices and Potentials for Research in Developing Countries. *Research in Globalization*. 2:1-10. <https://doi.org/10.1016/j.resglo.2020.100033>

Oyekale, A. 2018. Determinants of Households' Involvement in Waste Separation and Collection for Recycling in South Africa. *Environment, Development and Sustainability*. 20(5):2343-2371.

Paghasian, M.C. 2017. Awareness and Practices on Solid Waste Management among College Students in Mindanao State University Maigo School of Arts and Trades. *Proceedings of the 3rd International Conference on Education and Training (ICET 2017)*. 5-12. <https://www.atlantispress.com/proceedings/icet-17/25883492>

Palmer, P. 1998. Definitions of Waste. <http://www.interleaves.org/recycling/wastedef.html>. [Link cited by Agwadze 2020 not functional, for similar definition see Palmer, J.A. 1998. *Environmental Education in the 21st Century: Theory, Practice, Progress and Promise*. Routledge, London and New York. pp. 35 – 77).

Paritosh, K., Kushwaha, S.K., Yadav, M., Pareek, N., Chawade, A. & Vivekanand, V. 2017. Food Waste to Energy: An Overview of Sustainable Approaches for Food Waste Management and Nutrient Recycling. *BioMed Research International*.1-19. <https://doi.org/10.1155/2017/2370927>

Pasotti, E. 2010. Sorting through the Trash: The Waste Management Crisis in Southern Italy. *South European Society and Politics*. 15(2):289-307.

Pasternak, G., Zviely, D., Ribic, C.A., Ariel, A., Spanier, E., 2017. Sources, Composition and Spatial Distribution of Marine Debris along the Mediterranean Coast of Israel. *Marine Pollution Bulletin* 114(2): 1036–1045. <https://doi.org/10.1016/j.marpolbul.2016.11.023>

Paul, J.G., Arce-Jacque, J., Ravena, N. & Villamor, S.P. 2012. Integration of the Informal Sector into Municipal Solid Waste Management in the Philippines – What Does It Need? *Waste Management*. 32:2018-2028.

Peebles, J.A. 2003. Trashing South–central: Place and Identity in a Community-level Environmental Justice Dispute. *Southern Communication Journal*. 69(1):82-95.

Pellow, D.N. 2004. The Politics of Illegal Dumping: An Environmental Justice Framework. *Qualitative Sociology*. 27(94):511-525.

Pellow, D.N., Schnaiberg, A. & Weinberg A.S. 2000. Advanced Industrial Countries: Putting the Ecological Modernisation Thesis to the Test: The Promises and Performances of Urban Recycling. *Environmental Politics*. 9(1):109-137.

Permana, A.S., Towolioe, S., Aziz N.A. & Ho, C.S. 2015. Sustainable Solid Waste Management Practices and Perceived Cleanliness in a Low Income City. *Habitat International*. 49:197-205.

Perrault, E.K., Silk, K.J., Sheff, S., Ahn, J., Hoffman, A. & Totzkay, D. 2015. Testing the Identifiable Victim Effect with both Animals and Human Victims in Anti-littering Messages. *Communication Research Reports*. 32(4): 294-303. <https://doi.org/10.1080/08824096.2015.1089857>

Phuong, N.T.L., Yabar, H. & Mizunoya, T. 2021. Characterization and Analysis of Household Solid Waste Composition to Identify the Optimal Waste Management Method: A Case Study in Hanoi City, Vietnam. *Earth*. 2:1046-1058. <https://doi.org/10.3390/earth2040062>

Porter, M.E. 2015. Marginal Recycling: Place and Informal Recycling in St. John's, Newfoundland. *Local Environment*. 1-16.

Portman M.E. & Brennan, R.E. 2017. Marine Litter from Beach-based Sources: Case Study of an Eastern Mediterranean Coastal Town. *Waste Management*. 69: 535-544. <http://dx.doi.org/10.1016/j.wasman.2017.07.040>

Post, J. & Obirih-Opareh, N. Partnerships and the Public Interest: Assessing the Performance of Public-Private Collaboration in Solid Waste Collection in Accra. *Space and Polity*. 7(1):45-63.

Powell, J. 2002. The Potential for Using Life Cycle Inventory Analysis in Local Authority Waste Management Decision Making. *Journal of Environmental Planning and Management*. 43(3):351-367.

Premkumar, A. & Susairaj, A.X. 2021. Household Solid Waste Management in Tamil Nadu: Issues and Challenges. *Towards Excellence: An Indexed, Refereed and Peer*

Reviewed Journal of Higher Education. 13(2):928-937.
<https://hrdc.gujaratuniversity.ac.in/Publication>

Purcell, M. & Magette, W.L. 2010. Attitudes and Behaviour towards Waste Management in the Dublin, Ireland Region. *Waste Management.* 30(10):1997-2006.

Purcell, M. & Magette, W.L. 2011. Targeted Intervention Strategies to Optimise Diversion of BMW in the Dublin, Ireland Region. *Waste Management.* 31(9):2180-2189.

Quested, T.E., Marsh, E., Stunell, D and Parry, A.D. 2013. Spaghetti soup: the complex world of food waste behaviours. *Resources, Conservation and Recycling* 79: 43-51. <https://doi.org/10.1016/j.resconrec.2013.04.011>

Quispe Mamani, J.C., Aguilar Pinto, S.L., Guevara Mamani, M., Mamani Flores, A., TintayaChoquehuanca, O., Catachura Vilca, A. & Madueño Portilla, R. 2021. Environmental economic valuation by the improvement in the management of solid waste in the city of Huancané, Puno-Peru. *Annals of R.S.C.B.* 25(4): 1218-1235.

Radwan, H.R.I., Jones, E. & Minoli, D. 2012. Solid Waste Management in Small Hotels: A Comparison of Green and Non-green Small Hotels in Wales. *Journal of Sustainable Tourism.* 20(4):533-550.

Rahardyan, B., Matsuto, T., Kakuta, Y. & Tanaka, N. 2004. Residents' Concerns and Attitudes towards Solid Waste Management Facilities. *Waste Management.* 24(5):437-451.

Rahim, M.H.I.A., Mohamed, S., Kasim, N., Rahmat, M. & Azmi, N. 2021. Challenges Towards Reducing Illegal Dumping Activities in the Construction Industry. *Journal of Social Transformation and Regional Development.* 3(2):75-84.
<https://doi.org/10.30880/jstard.2021.03.02.009>

Ramukhwatho, F.R., Du Plessis, R. & Oelofse, S. 2016. Household Food Wastage by Income Level: A Case Study of Five Areas in the City of Tshwane Metropolitan Municipality, Gauteng Province, South Africa. *Proceedings of the 23rd WasteCon Conference.* 17-21 October 2016. Johannesburg, South Africa.

Rath, J.M., Rubenstein, R.A., Curry, L.E., Shank, S.E., & Cartwright, J.C. 2012. Cigarette Litter: Smokers' Attitudes and Behaviors. *International Journal of Environmental Research and Public Health.* 9:2189-2203. <https://doi.org/10.3390/ijerph9062189>.

Rayon-Viña, F., Miralles, L., Fernandez-Rodríguez, S., Dopico, E. & Garcia-Vazquez, E. 2019. Marine Litter and Public Involvement in Beach Cleaning: Disentangling Perception and Awareness Among Adults and Children, Bay of Biscay, Spain. *Marine Pollution Bulletin.* 141: 112-118. <https://doi.org/10.1016/j.marpolbul.2019.02.034>

Razali, F., Daud, D., Weng-Wai, C. & Jiram, W.R.A. 2020. Waste Separation at Source Behaviour Among Malaysian Households: The Theory of Planned Behaviour with Moral Norm. *Journal of Cleaner Production.* 271. <https://doi.org/10.1016/j.jclepro.2020.122025>

Redlingshöfer, B., Barles, S. & Weisz, H. 2020. Are Waste Hierarchies Effective in Reducing Environmental Impacts from Food Waste? A Systematic Review for OECD Countries. *Resources, Conservation and Recycling*. 156. <https://doi.org/10.1016/j.resconrec.2020.104723>

Renz, M.A. 1992. Communicating about Environmental Risk: An Examination of a Minnesota County's Communication on Incineration [Abstract]. *Journal of Applied Communication Research*. 20:1-18.

Ripa, M., Fiorentino, G., Vacca, V. & Ulgiati, S. 2017. The Relevance of Site-specific Data in Life Cycle Assessment (LCA). The Case of the Municipal Solid Waste Management in the Metropolitan City of Naples (Italy). *Journal of Cleaner Production*. 142:445-460.

Rispo, A., Williams, I.D. & Shaw, P.J. 2015. Source Segregation and Food Waste Prevention Activities in High-density Households in a Deprived Urban Area. *Management*. 44:15-27.

Rochman, F.F., Ashton, W.S. & Wiharjo, M.G.M. 2017. E-waste, Money and Power: Mapping Electronic Waste Flows in Yogyakarta, Indonesia. *Environmental Development*. 24:1-8.

Rodríguez-Rodríguez, D. 2012. Littering in Protected Areas: A Conservation and Management Challenge - A Case Study from the Autonomous Region of Madrid, Spain. *Journal of Sustainable Tourism*. 20(7):1011-1024. <https://doi.org/10.1080/09669582.2011.651221>

Rogerson, C.M. 2001. The Waste Sector and Informal Entrepreneurship in Developing World Cities. *Urban Forum*. 12(2):247-259.

Roper, S. and Parker, C. 2008. The Rubbish of Marketing. *Journal of Marketing Management*. 24(9-10): 881-892. <https://doi.org/10.1362/026725708X381948>

Ross, D.E. 2018. An Autobiography of Solid Waste Management. *Waste Management & Research*. 36(5):405-407.

Rydant, A.L. & Smith, J.P. 2001. Research Article: Identifying Historical Hazardous Waste Sites: Inputs to Urban Regeneration Planning [Abstract]. *Environmental Practice*. 3(3):163-178.

Sakai, S., Yano, J., Hirai, Y., Asari, M., Yanagawa, R., Matsuda, T., Yoshida, H., Yamada, T. et al. 2017. Waste Prevention for Sustainable Resource and Waste Management. *Journal of Material Cycles and Waste Management*. 19(4):1295-1313.

Sakinah, W., Septiningtyas, D.T. & Pahlewi, A.D. 2018. Domestic Waste Mass Estimation and Perceptions of Coastal Citizen about Waste Management in Besuki Region, Situbondo, East Java, Indonesia. *MATEC Web of Conferences*. 177:1-7.

Salemdeeb, R., Vivanco, D.F., Al-Tabbaa, A., Zu Ermgassen, E.K.H.J. 2017. A Holistic Approach to the Environmental Evaluation of Food Waste Prevention. *Waste*

Management. 59:442-450.

Salihoglu, G., Salihoglu, N.K., Ucaroglu, S., Banar, M. 2018. Food loss and waste management in Turkey. *Bioresource Technology*. 248:88-99.

Salvia, M., Di Leo, S., Nakos, C., Maras, H., Panevski, S., Fülöp, O., Papagianni, S., Tarevska, Z., Ceh, D. et al. 2015. Creating a Sustainable and Resource Efficient Future: A Methodological Toolkit for Municipality. *Renewable and Sustainable Energy Reviews*. 50:480-496.

Samson, M. 2015. Accumulation by Dispossession and the Informal Economy - Struggles Over Knowledge, Being and Waste at a Soweto Garbage Dump. *Environment and Planning D: Society and Space*. 33:813-830.

Sandhu, K., Burton, P. & Dedekorkut-Howes, A. 2017. Between Hype and Veracity; Privatization of Municipal Solid Waste Management and its Impacts on the Informal Waste Sector. *Waste Management*. 59:545-556.

Santos, A.C., Mendes, P. & Teixeira, M.R. 2019. Social Life Cycle Analysis as a Tool for Sustainable Management of Illegal Waste Dumping in Municipal Services. *Journal of Cleaner Production*. 210:1141-1149.

Sarkodie, S.A. & Owusu, P.A. 2021. Impact of COVID-19 Pandemic on Waste Management. *Environment, Development and Sustainability*. 23:7951-7960. <https://doi.org/10.1007/s10668-020-00956-y>

Sasao, T. 2016. Econometric Analysis of Cleanup of Illegal Dumping Sites in Japan: Removal or Remedial Actions? *Environmental Economics & Policy Studies*. 18(4):485-497.

Scheinberg, A., Spies, S., Simpson, M.H. & Mol, A.P.J. 2011. Assessing Urban Recycling in Low- and Middle-income Countries: Building on Modernised Mixtures. *Habitat International*. 35(2):188-198.

Schenck, R. & Blaauw, P.F. 2011. The Work and Lives of Street Waste Pickers in Pretoria - A Case Study of Recycling in South Africa's Urban Informal Economy. *Urban Forum*. 22:411-430.

Schenck, R., Blaauw, P.F. & Viljoen, K. 2016. Enabling Factors for the Existence of Waste Pickers: A Systematic Review. *Social Work/Maatskaplike Werk*. 52:35-53.

Schenck, C., Grobler, L., Blaauw, D. & Viljoen, K. 2021. Commuters' perceptions of littering on trains in South Africa: A case for environmental social work. *African Journal of Social Work and Social Development*. 33(3). <https://doi.org/10.25159/2708-9355/9951>

Schenck, C., Grobler, L., Viljoen, K., Blaauw, D. & Letsoalo J. 2021. Double whammy wicked: Street vendors and littering in Mankweng Township and Paarl, South Africa - Towards people-centred governance. *Urban Forum*. <https://doi.org/10.1007/s12132-021-09455-3>

Schindler, S. & Kishore, B. 2015. Why Delhi Cannot Plan its 'New Towns': The Case of Solid Waste Management in Noida. *Geoforum*. 60:33-42.

Schmidt, K. 2016. Explaining and Promoting Household Food Waste-prevention by an Environmental Psychological Based Intervention Study. *Resources, Conservation & Recycling*. 111:53-66.

Schneider, F. 2013. The Evolution of Food Donation with Respect to Waste Prevention. *Waste Management*. 33(3):755-763.

Schneider, A., & Ingram, H. 1990. Behavioral assumptions of policy tools. *The Journal of Politics*. 52(2): 510–529. <https://doi.org/10.2307/2131904>

Schneller, A.J. 2008. Environmental Service Learning: Outcomes of Innovative Pedagogy in Baja California Sur, Mexico. *Environmental Education Research*. 14(3): 291-307. <https://doi.org/10.1080/13504620802192418>

Schreck, M. & Wagner, J. 2017. Incentivizing Secondary Raw Material Markets for Sustainable Waste Management. *Waste Management*. 67:354-359.

Schubert, C. 2017. Green Nudges: Do They Work? Are They Ethical? *Ecological Economics*. 132:329-342.

Schultz, P.W., Bator, R.J., Large, L.B., Bruni, C.M. & Tabanico, J.J. 2013. Littering in Context: Personal and Environmental Predictors of Littering Behavior. *Environment and Behavior*. 45(1): 35-59. <https://doi.org/10.1177/0013916511412179>

Scialabba, N., Müller, A., Schader, C., Schmidt, U., Schwegler, P., Fujiwara, D. & Ghoreishi, Y. 2014. Food Wastage Footprint: Full-Cost Accounting (Final Report). <https://www.fao.org/3/i3991e/i3991e.pdf>

Sealey, K.S. & Smith, J. 2014. Recycling for Small Island Tourism Developments: Food Waste Composting at Sandals Emerald Bay, Exuma, Bahamas. *Resources, Conservation & Recycling*. 92:25-37.

Šedová, B. 2016. On Causes of Illegal Waste Dumping in Slovakia. *Journal of Environmental Planning and Management*. 59:1277-1303.

Sembing, E. & Nitivattananon, V. 2010. Sustainable Solid Waste Management toward an Inclusive Society: Integration of the Informal Sector. *Resources, Conservation & Recycling*. 54(11):802-809.

Sentime, K. 2014. The Impact of Legislative Framework Governing Waste Management and Collection in South Africa. *African Geographical Review*. 33(1):81-93.

Seng, B., Fujiwara, T. & Spoann, V. 2018. Households' Knowledge, Attitudes, and Practices toward Solid Waste Management in Suburbs of Phnom Penh, Cambodia. *Waste Management & Research*. 36(10):993-1000.

Seror, N., Hareli, S. & Portnov, B.A. 2014. Evaluating the Effect of Vehicle Impoundment Policy on Illegal Construction and Demolition Waste Dumping: Israel as a Case Study. *Waste Management*. 34:1436-1445.

Seror, N. and Portnov, B.A. 2020. Estimating the Effectiveness of Different Environmental Law Enforcement Policies on Illegal C&D Waste Dumping in Israel. *Waste Management*. 102: 241-248. <https://doi.org/10.1016/j.wasman.2019.10.043>

Sessa, A., Di Giuseppe, G., Marinelli, P. & Angelillo, I.F. 2010. Public Concerns and Behaviours towards Solid Waste Management in Italy. *European Journal of Public Health*. 20(6):631-633, <https://doi: 10.1093/eurpub/ckp204>.

Seth, K., Cobbina, S.J., Asare, W. & Duwiejuah, A.B. 2014. Household Demand and Willingness to Pay for Solid Waste Management Service in Tuobodom in the Techiman-North District, Ghana. *American Journal of Environmental Protection*. 2(4):74-78. doi:10.12691/env-2-4-3

Sharma, P., Gaur, V.K., Kim, S-H. & Pandey, A. 2020. Microbial Strategies for Bio-transforming Food Waste into Resources. *Bioresource Technology*. 299. <https://doi.org/10.1016/j.biortech.2019.122580>

Sharma, P., Gaur, V.K., Sirohi, R., Varjani, S., Kim, S.H. & Wong, J.W.C. 2021. Sustainable Processing of Food Waste for Production of Bio-based Products for Circular Economy. *Bioresource Technology*. 325:1-12. <https://doi.org/10.1016/j.biortech.2021.124684>

Sharma, G., Jaldhari, S. & David, S. 2019. A Study of Littering Behavior of Students of Devi Ahilya University with respect to Clean India Mission. *UNNAYAN: International Bulletin of Management and Economics*. XI: 266-279

Sheau-Ting, L., Sin-Yee, T. & Weng-Wai, C. 2016. Preferred Attributes of Waste Separation Behaviour: An Empirical Study. *Procedia Engineering*. 145:738-745.

Shen, H-W. & Yu, Y-H. 1997. Social and Economic Factors in the Spread of the NIMBY Syndrome against Waste Disposal Sites in Taiwan. *Journal of Environmental Planning and Management*. 40(2):273-282.

Shinkuma, T. & Managi, S. 2012. Effectiveness of Policy against Illegal Disposal of Waste. *Environmental Economics and Policy Studies*. 14:123-145.

Sigman, H. 1998. Midnight Dumping: Public Policies and Illegal Disposal of Used Oil. *RAND Journal of Economics*. 29(1):157-178.

Sikora, V.A. 2015. Illegal Dumping, Annexation, and Demolition, Seafood Trade Secrets, and More on Oysters. *Journal of Environmental Health*. 66(6):62-64.

Simatele, D.M., Dlamini, S. & Kubanza, N.S. 2017. From Informality to Formality: Perspectives on the Challenges of Integrating Solid Waste Management into the Urban Development and Planning Policy in Johannesburg, South Africa. *Habitat International*. 63:122-130.

Simatele, D. & Etambakonga, C.L. 2015. Scavenging for Solid Waste in Kinshasa: A Livelihood Strategy for the Urban Poor in the Democratic Republic of Congo. *Habitat International*. 49:266-274.

Singh, N., Cranage, D. & Lee, S. 2014. Green Strategies for Hotels: Estimation of Recycling Benefits. *International Journal of Hospitality Management*. 43:13-22.

Singhirunnusorn, W., Donlakorn, K. & Kaewhanin, W. 2012. Contextual Factors Influencing Household Recycling Behaviours: A Case of Waste Bank Project in Mahasarakham Municipality. *Procedia – Social and Behavioral Sciences*. 36:688-697.

Situ, Y. 1998. Public Transgression of Environmental Law: A Preliminary Study. *Deviant Behaviour*. 19(2):137-155.

Slavin, C, Garage, A & Campbell, M.L. 2012. Linking Social Drivers of Marine Debris with Actual Marine Debris on Beaches. *Marine Pollution Bulletin* 1580-1588. <https://doi.org/10.1016/j.marpolbul.2012.05.018>

Smelev, S.E. & Powell, J.R. 2006. Ecological-economic Modelling for Strategic Regional Waste Management Systems. *Ecological Economics* 59(1):115-130.

Somaroo, G.D. & Oomesh, G. 2015. Localised Approach to Solid Waste Dynamics, Life-cycle Assessment, Institutional and Legislative Frameworks. In *Future Directions of Municipal Solid Waste Management in Africa*. Mohee, R. & Simelane, T. (eds). Pretoria: Africa Institute of South Africa.

Song, Q., Wang, Z. & Li, J. 2016a. Exploring Residents' Attitudes and Willingness to Pay for Solid Waste Management in Macau. *Environmental Science and Pollution Research International*. 23(16):16456-16462.

Song, Q., Wang, Z. & Li, J. 2016b. Residents' Attitudes and Willingness to Pay for Solid Waste Management in Macau. *Procedia Environmental Sciences*. 31:635-643.

Sotamenou, J., De Jaeger, S. & Rousseau, S. 2019. Drivers of Legal and Illegal Solid Waste Disposal in the Global South – The Case of Households in Yaoundé (Cameroon). *Journal of Environmental Management*. 240:321-330.

Spenneman, D.H.R. 2021. COVID Face Masks: Policy Shift Results in Increased Littering. *Sustainability*. 13. <https://doi.org/10.3390/su13179875>

Spoann, V., Fujiwara, T., Seng, B. & Lay, C. 2018. Municipal Solid Waste Management: Constraints and Opportunities to Improve Capacity of Local Government Authorities of Phnom Penh Capital. *Waste Management & Research*. 36(10):985-992.

Stigler-Granados, P., Fulton, L., Patlan, E.N., Terzyk, M. & Novotny, T.E. 2019. Global Health Perspectives on Cigarette Butts and The Environment. *International Journal of Environmental Research and Public Health*. 16(10):16-24. <https://doi.org/10.3390/ijerph16101858>

Storrier, K.L. and McGlashan, D.J. 2006. Development and Management of a Coastal Litter Campaign: The Voluntary Coastal Partnership Approach. *Marine Policy*. 30: 189-196.

Strydom, W.F. 2018. Barriers to Household Waste Recycling: Empirical Evidence from South Africa. *Recycling*.

Strydom, W.F. & Godfrey, L.K. 2016. Household Waste Recycling Behaviour in South Africa – Has There Been Progress in the Last 5 Years? *Proceedings of the 23rd WasteCon Conference*. 17-21 October 2016. Johannesburg, South Africa.

Sultana, S., Islam, M.S., Jahan, F. & Khatun, F. 2021. Awareness and Practice on Household Solid Waste Management among the Community People. *Open Journal of Nursing*. 11(5):349-366. <https://doi.org/10.4236/ojn.2021.115031>

Sumbodo, B.T., Sardi, R.S., Prasetyanta, H. & Kusdarjito, C. 2021. Analysis of the Quadrant Strategy for Household Solid Waste Management (Case Study: BUMDes Amarta, Pandowoharjo Village Sleman Yogyakarta). *Proceedings of the 739 IOP Conference Series: Earth and Environmental Science*. doi:10.1088/1755-1315/739/1/012022

Sumukwo, J., Kiptui, M. & Cheserek, G.J. 2012. Economic Valuation of Improved Solid Waste Management in Eldoret Municipality. *Journal of Emerging Trends in Economics and Management Sciences*. 3(6):962-97.

Sunday, A.F. & Babajide, I.A. 2020. User Charges and Illegal Wastes Dumping: A Study of Lagos State Nigeria. *International Journal of Research in Arts and Social Sciences*. 13:182-200.

Suttibak, S. & Nitivattananon, V. 2008. Assessment of Factors Influencing the Performance of Solid Waste Recycling Programs. *Resources, Conservation & Recycling*. 53(1):45-56.

Tadesse, T., Ruijs, A. & Hagos, F. 2008. Household Waste Disposal in Mekelle City, Northern Ethiopia. *Waste Management*. 28(10):2003-2012.

Tait, P.R., Friesen, L. & Cullen, R. 2005. Will Unit Pricing Reduce Domestic Waste? Lessons from a Contingent Valuation Study. *New Zealand Economic Papers*. 39(1):83-103.

Tanyanyiwa, V.I. 2015. Motivational Factors Influencing Littering in Harare's Central Business District (CBD), Zimbabwe. *IOSR Journal of Humanities and Social Science*. 20(2):58-65. DOI: 10.9790/0837-20245865

Tapp, J.L. 1980. Psychological and Policy Perspectives in the Law: Reflections on a Decade. *Journal of Social Issues*. 36(2):165-192.

Tartiu, V. 2011. Evaluation of Attitudes and Knowledge Regarding Municipal Waste among Students. Case Study: Bucharest Academy of Economic Studies. *Economia: Seria Management*. 14(1):263-276.

Tasaki, T., Kawahata, T., Osako, M., Matsui, Y., Takagishi, S., Morita, A. & Akishima, S. 2007. A GIS-based Zoning of Illegal Dumping Potential for Efficient Surveillance. *Waste Management*. 27:256-267.

Tchobanoglous, G., Theisen, H. & Eliassen, R. 1977. *Solid Wastes: Engineering Principles and Management Issues*. New York: McGraw-Hill.

Tencati, A., Pogutz, S., Moda, B., Brambilla, M. & Cacia, C. 2016. Prevention policies addressing packaging and packaging waste: Some emerging trends. *Waste Management*. 56:35–45.

Tesfaldet, Y.T., Ndeh, N.T., Budnard, J. & Treeson, P. 2021. Assessing Face Mask Littering in Urban Environments and Policy Implications: The Case of Bangkok. *Science of the Total Environment*. 806. <https://doi.org/10.1016/j.scitotenv.2021.150952>

Teym, A. 2021. Assessment of Household Solid Waste Management and Hygienic Practice in Yebu Town, Jimma Zone, South Western Ethiopia. *International Journal of Waste Resources*. 11(9):1-9.

Thaler, R.H. & Sunstein, C.R. 2008. *Nudge: Improving Decisions about Health, Wealth and Happiness*. New Haven, CT: Yale University Press.

Thøgersen, J. 2009. The Motivational Roots of Norms for Environmentally Responsible Behavior. *Basic and Applied Social Psychology*. 31:348-362.

Tiew, K-G., Basri, N.E.A., Deng, H., Watanabe, K., Zain, S.M. & Wang, S. 2019. Comparative Study on Recycling Behaviours between Regular Recyclers and Non Regular Recyclers in Malaysia. *Journal of Environmental Management*. 237:255-263.

Tipple, G. 2005. Pollution and Waste Production in Home-Based Enterprises in Developing Countries: Perceptions and Realities. *Journal of Environmental Planning and Management*. 48(2):275-299.

Tonglet, M., Phillips, P.S. & Read, A.D. 2004. Using the Theory of Planned Behaviour to investigate the determinants of recycling behavior: a case study from Brixworth, UK. *Resources, Conservation and Recycling*. 41(3):191-214.

Toteng, E.N., Mbaiwa, J.E. & Moswete, N.N. 2005. Community Attitudes and Perceptions towards Urban Ecological Issues in Maun and Gaborone, Botswana. *Botswana Notes and Records*. 37:108-124.

Triassi, M., Alfano, R., Illario, M., Nardone, A., Caporale, O. & Montuori, P. 2015. Environmental Pollution from Illegal Waste Disposal and Health Effects: A Review on the 'Triangle of Death'. *International Journal of Environmental Research and Public Health*. 12:1216-1236.

Trung, D.N. & Kumar, S. 2005. Resource Use and Waste Management in Vietnam Hotel Industry. *Journal of Cleaner Production*. 13:109-116.

Tsalis, T., Amarantidou, S., Calabró, P., Nikolaou, I. & Komilis, D. 2018. Door-to-door recyclables collection programmes: Willingness to participate and influential factors with a case study in the city of Xanthi (Greece). *Waste Management & Research*. 36(9):760-766.

Tseng, M-L. 2011. Importance-performance Analysis of Municipal Solid Waste Management in Uncertainty. *Environmental Monitoring and Assessment*. 172(1):171-187.

Tukahirwa, J.T., Mol, A.P.J. & Oosterveer, P. 2013. Comparing Urban Sanitation and Solid Waste Management in East African Metropolises: The Role of Civil Society Organizations. *Cities*. 30:204-211.

Tukahirwa, J.T., Mol, A.P.J. & Oosterveer, P. 2011. Access of Urban Poor to NGO/CBO-supplied Sanitation and Solid Waste Services in Uganda: The Role of Social Proximity. *Habitat International*. 35(4):582-591.

Tunnell, K.D. 2008. Illegal Dumping: Large and Small Scale Littering in Rural Kentucky. *Southern Rural Sociology (Suppl Special Issue: Rural Crime)*. 23(2):29-42.

Turcott Cervantes, D.E., López Martínez, A., Cuartas Hernández, M. & Lobo Carcía de Cortázar, A. 2018. Using Indicators as a Tool to Evaluate Municipal Solid Waste Management: A Critical Review. *Waste Management*. 80:51-63.

Uhunamure, S.E., Nethengwe, N.S., Shale, K., Mudau, V. & Mokgoebo, M. 2021. Appraisal of Households' Knowledge and Perception towards E-Waste Management in Limpopo Province, South Africa. *Recycling*. 6(39):1-17.

Ulhasanah, N. & Goto, N. 2018. Assessment of Citizens' Environmental Behavior toward Municipal Solid Waste Management for a Better and Appropriate System in Indonesia: A Case Study of Padang City. *Journal of Material Cycles and Waste Management*. 20(2):1257-1272.

Umar, A.T. & Aondowase, N.S. 2021. Identifying the Causes of Indiscriminate Dumping of Waste in Jalingo Metropolis: A Structural Equation Modeling (SEM) Approach. *ADSU Journal of Applied Economics, Finance and Management*. 6(1):1-10.

United States Environmental Protection Agency. 2020. Advancing Sustainable Materials Management: 2018 Fact Sheet: Assessing Trends in Materials Generation and Management in the United States [cited as 2018 in Abegaz, Molla and Ali 2021] https://www.epa.gov/sites/production/files/2021-01/documents/2018_ff_fact_sheet_dec_2020_fnl_508.pdf

Valiente, R, Escobar, F., Pearce, J., Bilal, U., Franco, M. & Sureda, X. 2020. Estimating and Mapping Cigarette Butt littering in Urban Environments: A GIS Approach. *Environmental Research*. 183. <https://doi.org/10.1016/j.envres.2020.109142>

Van der Merwe, H. & Steyl, I. 2005. Solid Waste Management in Intensively Farmed Rural Areas: A Western Cape Case Study. *Acta Academica* 37(3):184-211.

Veiga, J.M., Vlachogianni, T., Pahl, S., Thompson, R.C., Kopke, K., Doyle, T.K., Hartley, B.L., Maes, T. et al. 2016. Enhancing Public Awareness and Promoting Co-responsibility for Marine Litter in Europe: The Challenge of MARLISCO. *Marine Pollution Bulletin*. 102(2):309-315.

Victor, D. & Agamuthu, P. 2013. Strategic Environmental Assessment Policy Integration Model for Solid Waste Management in Malaysia. *Environmental Science and Policy*. 33:233-245.

Viebahn, P. 2002. An environmental management model for universities: from environmental guidelines to staff involvement. *Journal of Cleaner Production*. 10: 3-12.

Volker, B. 2017. Revisiting Broken Windows: The Role of Neighborhood and Individual Characteristics in Reaction to Disorder Cues. *Sociological Science*. 4. DOI: 10.15195/v4.a22

Von Kameke, C. & Fischer, D. 2018. Preventing Household Food Waste via Nudging: An Exploration of Consumer Perceptions. *Journal of Cleaner Production*. 184:32-40. <https://doi.org/10.1016/j.jclepro.2018.02.131>

Vos, M.C., Galetzka, M., Mobach, M.P., Van Hagen, M. & Ad T.H. Pruyn, A.T.H. 2018. Cleanliness Unravelling: A Review and Integration of Literature. *Journal of Facilities Management*. 16(4): 429-451. <https://doi.org/10.1108/JFM-06-2017-0025>

Wagner, J. 2011. Incentivizing sustainable waste management. *Ecological Economics*. 70(4):585-594.

Wagner, T. 2004. Hazardous Waste: Evolution of a National Environmental Problem. *The Journal of Policy History*. 16(4):306-331.

Wassihun, G.W. & Gichamo, B.W. 2019. Unison to Post-modernism or a Risky Radicalized Approach? Environmental Citizenship for Waste Management as a Reflex of Identity Claims in Wolkite Town. *Journal of Waste Management and Disposal*. 1(2):1-8.

Watts, A.J.R., Porter, A., Hembrow, N., Sharpe, J., Galloway, T.S. & Lewis, C. 2017. Through the Sands of Time: Beach Litter Trends from Nine Cleaned North Cornish Beaches. *Environmental Pollution*. 228:416-424. <http://dx.doi.org/10.1016/j.envpol.2017.05.016>

Weaver, L. 2015. Littering in context(s): Using a quasi-natural experiment to explore geographic influences on antisocial behaviour. *Applied Geography*. 57:142-153.

Wen, Z., Chen, C., Ai, N., Bai, W., Zhang, W. & Wang, Y. 2019. Environmental impact of carbon cross-media metabolism in waste management: A case study of municipal solid waste treatment systems in China. *Science of The Total Environment*. 674:512-523. doi:10.1016/j.scitotenv.2019.04.154

Wever, .R, Van Onselen, L., Silvester, S. & Boks, C. 2010. Influence of Packaging Design on Littering and Waste Behaviour. *Packaging Technology and Science*. 23(5):239-252.

Wiesmeth, H. & Häckl, D. 2011. How to successfully implement extended producer responsibility: Considerations from an economic point of view. *Waste Management and Research*. 29(9):891–901.

Wiesmeth, H., Shavgulidze, N. & Tevzadze, N. 2018. Environmental Policies for Drinks Packaging in Georgia: A Mini-review of EPR Policies with a Focus on Incentive Compatibility. *Waste Management & Research*. 36(11):1004-1015.

Willems, E.P. & McIntire, J.D.. 1982. A Review of *Preserving the Environment: New Strategies for Behavior Change*, Edited by Geller, Winett, & Everett. *The Behavior Analyst*. 5:191-197.

Willis, K., Hardesty, B.D., Kriwoken, L. & Wilcox, C. 2017. Differentiating Littering, Urban Runoff and Marine Transport as Sources of Marine Debris in Coastal and Estuarine Environments. *Scientific Reports*. 7. doi: 10.1038/srep44479

Wilts, H., Dehoust, G., Jepsen, D. & Knappe, F. 2013. Eco-innovations for Waste Prevention – Best Practices, Drivers and Barriers. *Science of the Total Environment*. 461-462.

World Bank. 2020. *What a Waste: A Global Review of Solid Waste Management*. Available at: <https://openknowledge.worldbank.org/handle/10986/17388> (accessed 21 February 2022).

Wright, B., Smith, L. & Tull, F. 2018. Predictors of Illegal Dumping at Charitable Collection Points. *Waste Management*. 70:30-36.

Wulandhary, S., Soesilo, T.E.B., Moersidik, S.S. & Asteria, D. 2019. Protecting water resources by sustainable household solid waste management in Jakarta, Indonesia. *Proceedings of the IOP Conference Series: Earth and Environmental Science 399: The International Seminar on Natural Resources and Environmental Management*. 15 August 2019. Bogor, Indonesia.

Wynne, A.L., Nieves, P., Vulava, M.V., Qirko, H.N. & Callahan, T.J. 2018. A Community-based Approach to Solid Waste Management for Riverine and Coastal Resource Sustainability in the Philippines. *Ocean and Coastal Management*. 151:36-44.

Yadav, P. & Samadder, S.R. 2018. A Critical Review of the Life Cycle Assessment Studies on Solid Waste Management in Asian Countries. *Journal of Cleaner Production*. 185:492-515.

Yang, W., Fan, B. & Desouza, K.C. 2019. Spatial-temporal Effect of Household Solid Waste on Illegal Dumping. *Journal of Cleaner Production*. 227: 313-324. <https://doi.org/10.1016/j.jclepro.2019.04.173>

Yau, Y. 2010. Domestic Waste Recycling, Collective Action and Economic Incentive: The Case in Hong Kong. *Waste Management*. 30:2440–2447.

Yeung, I. & Chung, W. 2018. Factors that Affect the Willingness of Residents to Pay for Solid Waste Management in Hong Kong. *Environmental Science and Pollution Research*. 25(8):7504-7517.

Ylä-Mella, J., Keiski, R.L. & Pongrácz, E. 2015. Electronic Waste Recovery in Finland: Consumers' Perceptions towards Recycling and Re-use of Mobile Phones. *Waste Management*. 45:374-384. <http://dx.doi.org/10.1016/j.wasman.2015.02.031>

Yoda, R.M., Chirawurah, D. & Adongo, P.B. 2014. Domestic Waste Disposal Practice and Perceptions of Private Sector Waste Management in Urban Accra. *BMC Public Health*. 14(1):697-706.

Yu, Q. & Li, H. 2020. Moderate separation of household kitchen waste towards global optimization of municipal solid waste management. *Journal of Cleaner Production*. 277:1-11. <https://doi.org/10.1016/j.jclepro.2020.123330>

Yusof, Z.B.B. & Jamaludin, M. 2015. Green Practices of Small Island Chalet Operators in East Peninsular Malaysia. *Procedia – Social and Behavioral Sciences*. 202.340-350.

Yusop, Y.M. & Othman, N. 2019. Linking the Malaysia's Solid Waste Management Policy Instruments with Household Recycling Behavior. *International Journal of Academic Research in Progressive Education and Development*. 8(4): 474-488. <http://dx.doi.org/10.6007/IJARPED/v8-i4/6567>

Yukalang, N., Clarke, B. & Ross, K. 2017. Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand. *International Journal of Environmental Research and Public Health*. 14(9).

Zainun, N.Y., Rahman, I.A. & Rothman, R.A. 2016. Mapping of Construction Waste Illegal Dumping Using Geographical Information System (GIS)" *IOP Conference Series: Materials Science and Engineering*.1-7.

Zaman, A.U., Swapan, M. & Shahidul, H. 2016. Performance Evaluation and Benchmarking of Global Waste Management Systems. *Resources, Conservation & Recycling*. 114.32-41.

Zambezi, F.M., Muisa-Zikali, N. & Utete, B. 2021. Effectiveness of Community Participation as Anti-litter Monitors in Solid Waste Management in Metropolitan Areas in a Developing Country. *Environment, Development and Sustainability*. 23:747-764. <https://doi.org/10.1007/s10668-020-00606-3>

Zambrano-Monserrate, M.A., Ruano, M.A. & Ormeño-Candelario, V. 2021. Determinants of Municipal Solid Waste: A Global Analysis by Countries' Income Level. *Environmental Science and Pollution Research*. 28:62421-62430.

Zero Waste Scotland “Nudge Study – Promoting the Use of Litter Bins”
<https://www.zerowastescotland.org.uk/litter-flytipping/nudge-study>

Zhang, Y.M., Huang, G.H. & He, L. 2011. An inexact reverse logistics model for municipal solid waste management systems. *Journal of Environmental Management*. 92(3):522-530.

Zhang, D.Q., Tan, S.K. & Gersberg, R.M. 2010. Municipal Solid Waste Management in China: Status, Problems and Challenges. *Journal of Environmental Management*. 91(8):1623-1633.

Zhen-shan, L., Lei, Y., Xiao-Yan, Q., Yu-mei, S. 2009. Municipal Solid Waste Management in Beijing City. *Waste Management*. 29(9):2596-2599. <https://doi.org/10.1016/j.wasman.2009.03.018> PubMed

Ziraba, A.K., Haregu, T.N. & Mberu, B. 2016. A Review and Framework for Understanding the Potential Impact of Poor Solid Waste Management on Health in Developing Countries. *Archives of Public Health*. 74:55-65.

Zorpas, A., Voukkali, I. & Loizia, P. 2017. Effectiveness of Waste Prevention Program in Primary Students' Schools. *Environmental Science and Pollution Research*. 24(16):14304-14311.

Zurbrügg, C., Drescher, S., Rytz, I., Sinha, A.H.M.M. & Enayetullah, I. 2005. Decentralised Composting in Bangladesh, a Win-win Situation for all Stakeholders. *Resources, Conservation & Recycling*. 43(3):281-292.

Council for Scientific and Industrial Research

Waste RDI Roadmap Implementation Unit

Meiring Naudé Road, Brummeria,
Pretoria, South Africa

Postal Address

PO Box 395, Pretoria, South Africa, 0001

Tel: +27 (0)12 841 4801

Fax: +27 (0)12 842 7687

Email: info@wasteroadmap.co.za

www.wasteroadmap.co.za

Department of Science and Innovation

Directorate: Environmental Services and Technologies

Meiring Naudé Road, Brummeria,
Pretoria, South Africa

Postal Address

Private Bag X894, Pretoria, South Africa, 0001

Tel: +27 (0)12 843 6300

www.dst.gov.za

