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Assessment of disposal methods of construction and demolition waste: A case study of south-eastern industrial and residential areas in Johannesburg, South Africa.

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DECLARATION

I, Vasti de Jager (2629660) declare that this dissertation is my unaided work. It is being submitted for the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

(Vasti de Jager)

2024/05/16

ABSTRACT

In a world where all strive for further development, construction and demolition play a large role in that process. The waste generated in construction and demolition projects is of great magnitude and needs to be dealt with and disposed of appropriately, however, is this truly the case? Gauteng is a province where landfills are easily accessible and a cheap disposal option. This study set out to assess disposal methods of construction and demolition waste in south-east Johannesburg, South Africa. Landfills and recycling were the prevalent disposal methods, and these were compared to other countries' disposal methods. Policy and legislation regarding solid waste management were analysed and a gap between written documents and implementation was identified. The question of sustainability also played a role in the synthesis of the study.

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This dissertation would not have been possible without several individuals who contributed in one way or another and it is a pleasure to acknowledge and thank them.

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I am also grateful to every single interview participant who took time out of their day to provide me with valuable information that was necessary to conduct this research. A special thank you to David Dworcan, who did more than was asked of him as well as other interview participants who have chosen to remain anonymous. This also goes out to any person who could not provide me with an interview but connected me to relevant participants.

Lastly, I'd like to recognise my wonderful husband who kept me motivated, made sure I was staying focused and on track as well as being supportive overall and believed in me.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1:

INTRODUCTION

1.1 Introduction

A significant amount of construction and demolition waste is generated each year and even though demolition and construction are two different actions, the waste products are grouped together in the literature (Park and Tucker, 2016). The activities for waste generation are categorised into new building construction, old building demolition, and civil works (Berge and Blottnitz, 2022). Construction and demolition waste is a growing concern, and many countries are placing priority on policies involved in the management thereof (Dahlbo *et al.,* 2015).

Due to urbanisation at such rapid rates in Asian countries, it is no surprise that construction and demolition waste environmental impacts have become an issue in waste management. Thus, certain Asian countries are conducting studies on the principles of reuse, reduce, recycle, and assist with developing policies and to formulate interventions (Nitivattananon and Borogan, 2007). Similarly, Park and Tucker (2016) identified the lack of progress in addressing construction waste reuse in Australia due to institutional barriers, including political, social, and economic, as well as attitudes regarding reuse practices. Countries such as Canada, understand that most of their landfill space is estimated to run out in 2027 and are taking the process of reuse, reduce, recycle seriously, they are working towards efficient mechanisms for integrated waste management, technologies, and policies (Yeheyis, *et al.* 2013).

South Africa is no exception when it comes to being forced to look at our construction and demolition waste management. There is a data issue regarding construction and demolition waste in South Africa as it is not understood or properly documented (Berge and Blottnitz, 2022). At an international conference in Dubai in 2020, it was indicated that the country's goals should be to try and divert waste from landfills but the opinions regarding this being a realistic expectation were split between waste reduction costing money and waste reduction saving money (Aboginije, *et al.* 2020). It is noted by Fitchett and Rambuwami (2022) that the contributions of the construction industry are significant to the economy of the country, however, it also has a large contribution to waste generation. In 2017, South Africa produced 5.3 million tons of construction and demolition waste, where 5.1 million tons ended up in landfill and only 305 761 tons were recycled (Department of Environmental Affairs, 2018). Therefore, these issues invite research attention.

1.2 Problem statement

The method of waste disposal on construction projects is determined by the contractor, who decides in which manner the waste will be dealt with. The construction company typically hires a waste management agency to take care of it, and often are unaware of what happens to the waste once it leaves the premises. Two evident ways of disposal are that the waste gets transported to a landfill, or to a facility where some of the waste, including bricks, cement, and soil, can be re-processed to be used again at a different construction site, as is being done in Taiwan (Lai, *et al.* 2016) and Australia (Park and Tucker, 2016).

One also cannot overlook illegal dumping as a disposal method by some as it is the easiest and does not incur any fees. It is at the discretion of the contractors whether they choose to make use of companies that provide this service or even use recycled materials in their construction project. Both methods have their benefits, e.g. landfill is easy and if the option is there, it prevents illegal dumping and re-purpose aids sustainability. However, an assessment is required to determine which of these methods would be better for sustainability and what their impacts are on the environment, the economy, technological necessity, and social aspects. Thus, the assessment should include the entire process from the generation of the waste, the storage thereof, the collection and transportation, and finally the disposal process.

A large role-player in these activities is that no clear current legislations refer to sustainable disposal of these types of waste. As these construction projects are private, it is easy for the disposal to go unnoticed and unchecked by any means of authority to ensure it is being done correctly or even sustainably. Acts such as the National Environmental Management Act of 1998, as well as its amendment in 2008 and 2013 regarding waste management do not legally bind construction companies or waste companies to dispose of the waste sustainably, but focus more on how it should be classified, collected, transported, and stored.

This study is guided by the following research questions:

- What are the current disposal methods of construction and demolition waste used in South Africa and how does it compare to other countries?
- Which of these methods is a more sustainable option to use?
- What part do legislation and policy play in the disposal of construction and demolition waste in South Africa?

1.3 Research aims and objectives

This research aims to assess the disposal methods of construction and demolition waste in South Africa in the south-eastern region of Johannesburg. This study will contribute to existing literature and knowledge of solid waste management, construction, and demolition waste disposal. The objectives to aid this study are to:

- Determine and compare current construction and demolition waste disposal methods used in South Africa and other countries.
- Assess the sustainability of disposal methods and determine which would be most beneficial for longevity.
- Assess the current legislation and policy frameworks that dictate the disposal of construction and demolition waste in South Africa's solid waste management.

1.4 Justification of the study and its significance

This study is necessary, as there is a large gap in the disposal of construction and demolition waste literature in Sub-Saharan Africa and South Africa. It is also relevant as it will not be as easy to follow other countries' management examples as our construction and demolition waste varies in type, i.e., South Africa makes use of bricks and concrete whereas some countries, such as the United States of America, Canada, and some Sub-Saharan countries use a lot of wood and drywall. Although there are various studies on general waste and specifically plastic, very little literature is available that is specific to construction and demolition waste in South Africa, which is imperative for developing countries where construction is constant.

Sustainability in construction and demolition waste disposal is of the utmost importance as developing nations move forward, ensuring the progress made does not come at the cost of the environment. Sustainable development needs a balance between the economy, environment, and society to thrive and truly be sustainable for future generations.

CHAPTER 2:

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 Introduction

A vital part of any construction project needs to be the management of the waste generated during the project and should aim to repurpose and reuse the generated waste (Ogunmakinde, *et al.,* 2019). This chapter will look at the available literature on the management of construction and demolition waste not only for South Africa but for Sub-Saharan African countries, developing countries as well as a brief overview of some more developed countries as well. The purpose of this is to determine how other countries are managing their construction and demolition waste and if the currently available literature falls short of providing insight into how other countries deal with construction and demolition waste specifically, not just general municipal waste. Each section will have a look at countries that fall within that region and how they manage the waste as well as if they have any innovative current or possible disposal methods. There is a consensus in most literature that policies regarding construction and demolition waste are lacking and a small section looks at policies and legislation in

South Africa, however, a more comprehensive policy analysis is conducted in a later chapter of the research.

Many companies strive to practice sustainable construction, even though it could be difficult at times (Ogunmakinde, *et al.,* 2019). It could be argued that the disposal of construction and demolition waste determines the effectiveness and success of waste management as it contributes to environmental degradation (Ogunmakinde, *et al.,* 2019). Not only is it important for environmental degradation, but some countries even see the opportunity for financial gain by treating or changing the composition of the waste to re-sell or reuse to save money (Ibrahim, *et al.,* 2022).

2.2 Definition of concepts

The National Environment Management Act, 1998 (Act no. 107) covers waste management as part of its broader scope of environmental management as it contains a legal framework and regulation of waste management practices in South Africa. The act contains section 19 which identifies the duty of care for all those involved in waste, while section 20 addresses waste management activity licensing and registration. The act is frequently referred to as NEMA. A United Nations Environmental Programme report (2015) referred to waste management as any involved process for handling, transport, storage, treatment, and acceptable disposal of waste materials. Not only is waste management important for the government to have a better understanding of current issues, but planning and analysis are also necessary to ensure proper identification of the main challenges in the short-term and long-term (Yuan, 2013).

The National Environmental Management: Waste Amendment Act, 2014 (Act no. 59 of 2009) defines waste as “any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, by the holder of the substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 to this Act”.

Construction and demolition waste is any matter, material, or thing construction work results in, whether stored or processed before it is abandoned (Yuan, 2013) or by-products of demolition, renovation, or construction by civil engineering or on any construction site (Tam *et al,* 2007:2). Shen *et al.* (2004) specify materials as wood, concrete, rubble, steel, and earth, however, the composition of construction and demolition waste, as well as the quantity, will vary in nature regarding factors from each region including population growth, the construction industry and legislation (Duan *et al.,* 2015) while contractor capability such as knowledge on sustainable construction and experience impact rates of waste generation (Luangcharoenrat *et al.,* 2019). Although the construction industry is involved in job creation for many, it is imperative that it starts alleviating environmental burdens (Bai *et al.,* 2016), which is why proper management of construction and demolition waste not only benefits the environment but prevents construction projects from cost overrun (Al-Btoosh *et al.,* 2023).

Recycled aggregate – crushed demolished concrete (or sometimes bricks, sand, or ceramics) that had contaminants removed and a few new ingredients added to form cement or bricks again to be used in construction projects (Junak & Sikakova, 2017:1285). Increased environmental protection awareness has resulted in an increase in companies looking into recycled aggregate to try to meet the demand for sustainable development (Wang *et al.,* 2021). These recycled aggregates can be

manufactured in two different ways, including having the debris transported to a stationary facility to be worked into new recycled aggregate, or there could be a mobile facility that is present on the construction site itself where the process does not require any transportation (Wang *et al.,* 2021). Wang *et al.* (2021) identify the manufacturing of recycled aggregate requires nine steps from the original material to the new usable product. These steps are reducing the size of the material, pre-separation, primary screening, primary crushing and magnetic separation, secondary screening, decontamination, final crushing, washing and air-sifting, and finally separating the aggregate for different uses (Wang *et al.,* 2021).

2.3 Assessment of disposal methods of Construction and demolition waste in Developing Countries

Generally, data regarding construction and demolition waste management specifically in developing countries are limited (Estrada *et al.,* 2023) and countries that are developing rapidly are contributing largely to the generation of construction and demolition waste, producing millions of tons annually (Akhtar & Sarmah, 2018). Despite contributing largely to waste, countries such as the Philippines do not have policies in place for efficient construction and demolition waste management, while rapid urbanisation continues to place a strain on environmental concerns (Estrada, *et al.,* 2023). In the Philippines, for example, landfilling and recycling of certain materials to produce recycled aggregate are popular, however, information on materials such as wood and steel is very limited (Estrada *et al.,* 2023). Thus, it is becoming more common to conduct life cycle assessments that determine the overall impact on the environment for different methods used (Estrada, *et al.,* 2023).

Similarly, these life cycle assessments have been conducted in India and Brazil (Rosado *et al., 2019;* Jain *et al.,* 2020). Currently, India has a lacking formal infrastructure for waste management and most construction and demolition waste gets mixed into municipal solid waste that either goes to landfill or gets openly dumped on illegal dumping sites, while some materials and a few whole bricks get salvaged and get sold in a secondary market (Ram & Kalidindi, 2017; Sekhar *et al*., 2015). Recycling stations have been few and far in India, however, in certain areas such as Delhi, all agents are advised to use 2% recycled products for buildings and no less than 10% for road construction (Delhi PWD, 2018). The government is slowly starting to respond and strengthen the regulatory frameworks for better construction and demolition waste management (Jain *et al.,* 2020). A life cycle assessment concluded that construction and demolition waste recycling could lessen the construction industry's impact on the environment (Jain, *et al.,* 2020).

In Brazil, for example, the government believes the management of any construction and demolition waste should be managed by the ones who generate the waste themselves (Brazil, 2002). However, the municipalities are responsible for registration and licensing areas that need to be available for sorting, delivery, and temporary storage for small amounts at a time, which aims to minimize illegal disposal and ultimately reduce cleaning expenses (Rosado *et al.,* 2019). A study in Sao Paulo, Brazil indicated that, most of the construction and demolition waste is designated for landfill with minimal recycling opportunities (Rosado *et al.,* 2019). However, much waste ends up illegally disposed as landfill sites that are up to 90km away, thus, new sorting areas from the municipality could reduce illegal disposal (Rosado *et al.,* 2019).

Brazilian cities' rapid growth combined with the illegal disposal of construction and demolition waste call for adequate policies from authorities and support to be able to

transition to a circular economy for construction systems (Doussoulin & Bittencourt, 2022). A study conducted by Abarca-Guerrero *et al.* (2022) in Costa Rica found various barriers to any type of recycling of construction and demolition waste categorised as technical, financial, social, environmental as well as legal aspects, while the recycled material market is also underdeveloped.

Countries such as Kuwait also suffer from poor waste management while highly making use of landfill for most of the waste, while having a designated landfill for construction and demolition waste, 60-85% of waste has been routed to any operating landfill (Albeeshi *et al.,* 2017). Producers of construction and demolition waste in Kuwait are not open to the idea of alternatives to landfill dumping as they believe it will increase production costs as all sites try to minimise any expenses involved (Al-Raqeb *et al.,* 2023).

A country widely known for its rapid growth is China, which needs clear-cut policies from the government to ensure proper management of construction and demolition waste (Wang *et al.,* 2021). The main disposal method is landfill, however, places such as Hangzhou are trying experimental techniques for alternatives, while policies are unclear and there is a lack of support from the government (Yu *et al.,* 2022).

In contrast to developing countries, many developed countries do not all participate in better disposal methods than landfilling. Looking at the Middle East, Egypt has the potential to make use of recycled aggregate, however, this is not the case and there are only plans in place for future recycling and reuse (Ibrahim, *et al.,* 2022). Saudi Arabia is not much better as 86.4% of its construction waste ends up in landfill along with the United Arab Emirates, which produce around 27.7 million tons of construction waste in landfills yearly (Ibrahim, *et al.,* 2022). While Lebanon disposes of much of

their construction waste by illegal dumping in valleys or abandoned quarries (Ibrahim, *et al.,* 2022). Syria, however, plans to reuse the debris that has been caused by the Syrian crisis that started in 2011 to rebuild homes and other buildings, with the project already underway experimentally (UNEP, 2020).

Alternatively, the European Union set out in 2008 in the Council Directive 2008/98/EC (2008), to have 70% of all construction and demolition waste either recycled, reused, or even recovered by the year 2020, however, many factors such as economics and policies are still preventing those percentages to be achieved (Spišáková, *et al.,* 2021).

Within the United States the legislation and policies around the management of construction and demolition waste urge each state to create and execute their own regulations (Jin and Chen, 2019), thus, it is different depending on the state. The United States provides core focus on stakeholders when it comes to construction and demolition waste management while there is a lack of government concern on how it is conducted (Aslam, *et al.,* 2020).

2.4 Assessment of disposal methods of construction and demolition waste in Sub-Saharan Africa

The cheapest and most common method of waste disposal in Sub-Saharan Africa remains landfilling; however, landfill sites that are not engineered pose a threat to groundwater and are also linked to volatile gases that escape into our environment (Idowu, *et al.,* 2019). As waste disposal increases, the negative impact of waste disposal sites on surrounding environments is heightened; these impacts could even stretch beyond the timeframe of the site's active years (Aryampa, *et al.,* 2021). Sub-

Saharan Africa is no stranger to the issues of weak legislative, institutional, and participative strategies when it comes to waste management and is in dire need of implementable and appropriate waste management strategies (Muheirwe, *et al., 2022).* A large role in disposal methods in Sub-Saharan countries is access to electricity and the disposal methods that are seen as more environmentally friendly and sustainable could require electricity use. Mshandete and Parawira (2009) indicated that biomass such as firewood and charcoal are used for energy needs that add on to environmental degradation.

Uganda typically makes use of landfill and burning of waste, while illegal dumping also occurs (Balcom, *et al.,* 2021). In a study by Balcom *et al.* (2021), possible disposal options for roof tiles were analysed, looking at simply disposing of the tiles completely in landfills was a viable option as all waste in Kampala goes to the Kiteezi landfill, even though it has reached full capacity. Another option was to use the tiles to act as fuel for incineration in cement kilns, which is in turn used to incinerate other types of waste or the tiles could be crushed and re-made into new roof tiles again (Balcom, *et al.,* 2021*).* Similarly, in Ethiopia, they have processes to convert waste such as plastic into aggregate, which goes back into the construction of pavements and roads (Genet, *et al.,* 2021).

A study conducted in Lagos State, Nigeria in 2019 found that landfilling, along with recycling and reusing certain materials as a filler, are the main disposal methods used, while some sites still burn some of their waste, regardless of their awareness of the environmental implications, because it is the cheapest option (Ogunmakinde, *et al.,* 2019). During interviews for the study, the participants indicated that it is the government's role to manage and re-sell the waste, however, a participant from the government indicated that the waste that is collected is disposed of in a landfill

(Ogunmakinde, *et al.,* 2019). Finally, the study indicated that it is common practice to give some of the waste to those who are interested in the community as they might still be able to use it while the construction company cannot (Ogunmakinde, *et al.,* 2019). It is also clear that policies regarding the management of construction waste in Nigeria are lacking and have been described as ambiguous (Dania, 2017).

Construction in Sub-Saharan Africa is focused on cement, rather than wood as in the United States and other countries whose buildings mostly comprise wood, and concrete is worldwide sufficiently available for construction material demand (Schmidt, *et al.,* 2021). However, concrete largely contributes to carbon emissions and should thus be used in a more efficient manner and scholars believe Sub-Saharan African countries could be at the forefront of developing greener and more innovative technologies to practice sustainable construction (Schmidt, 2017). Schmidt, *et al.* (2021) indicated the possibility of using waste ash from maize, peels of cassava, and rice husks to replace some percentages of cement. This, however, is still just theoretical and not physically implemented yet.

2.5 Assessment of disposal methods of construction and demolition waste in South Africa

Construction rates in South Africa are on the rise and the complexity of the projects continues to increase, thus adding to the already existing challenges of waste management in an effective manner (Ding *et al.,* 2018). Interestingly, plans for waste management for construction sites are not a requirement according to legislation in Gauteng, whereas in Cape Town it is required when any building plans are submitted (Fitchett & Rambuwami, 2022).

The policy landscape in South Africa stems from the legislation that is in place for any type of waste management, which is the National Environmental Management Act 1998 (Act 107) - referred to as NEMA. NEMA was amended in 2008 to create the new National Environmental Management: Waste Act (Act 59) known as NEMWA, which was amended in 2014. These documents, however, look at waste management in a broader umbrella than placing emphasis on demolition and construction waste management.

In 2012 the government gazette published the National Waste Information Regulations to regulate data collection and information on the state of waste disposal in the country to ensure the objectives of section 61 of NEMWA are met (Department of Environmental Affairs, 2012). This gazette also ensured the public knew how to correctly handle waste and how it must be set into data. To aid this, in the same year a gazette was published on information regarding waste management such as treatment and landfill use, along with how to classify waste (Department of Environmental Affairs, 2012:39) which was amended and published again a year later (Department of Environmental Affairs, 2013:3). The most recent legislative document regarding waste management appears to be the National Waste Management Strategy of 2020, which identifies construction and demolition waste to be the second largest contributor to general waste (Department of Environment, Forestry and Fisheries, 2020). The document recognises that the waste mostly goes to landfill or is dumped illegally, however, the strategy does set out goals of diverting construction and demolition waste from landfills and encourages recycling and reusing waste (Department of Environment, Forestry and Fisheries, 2020).

The main disposal method of construction and demolition waste in South Africa is primarily landfill, however, there are other options available to construction sites, that

the manager can choose to use. A study conducted by Fitchett and Rambuwami (2022) revealed that in certain construction sites that are brownfield and have loads of demolition, the site primarily reused materials and only purchased when required to do so, while other different sites made use of rubble to act as fill, however, most made use of landfill as their disposal method.

It is noted that a large percentage of construction and demolition waste can be recycled to keep the capacity of landfills at a manageable level and with evidently diminishing landfill space, other management issues have become imperative not only to minimise the effect on the environment but also to help with sustainable growth (Aboginije, *et al.,* 2020). In a report on the state of waste by the Department of Environmental Affairs (2018) it was mentioned that construction and demolition waste contribute to one of the largest streams of generated waste in South Africa. However, there is a severe lack of data as many municipalities are not reporting their data. The report mentioned possible recycling methods for construction and demolition waste including crushing to create aggregate and the reuse of certain materials. According to the statistics from 2018, an estimated 52% of construction and demolition waste in South Africa is recycled (Department of Environmental Affairs, 2018).

2.6 Theoretical Framework

This study finds value in Thompson's Rubbish Theory (1979). The theory revolves around the idea that something is only classified as rubbish or waste when one person does not see any further value in the item, however, it could be seen as waste until found by someone else who sees it for a different purpose and value and therefore it

is no longer seen as ‘rubbish’ anymore (Thompson, 1979). In an article by Liz Parsons (2007), she used the theory to look at consumer behaviour and finding the link between consumerism and Rubbish Theory. The theory places focus on categorising items and that the category is strongly reliant on those who decide where they fall, and some items are more durable than others and therefore would be able to be re-seen as valuable later (Thompson, 1979). Thus, items could follow the lifecycle that is indicated below:

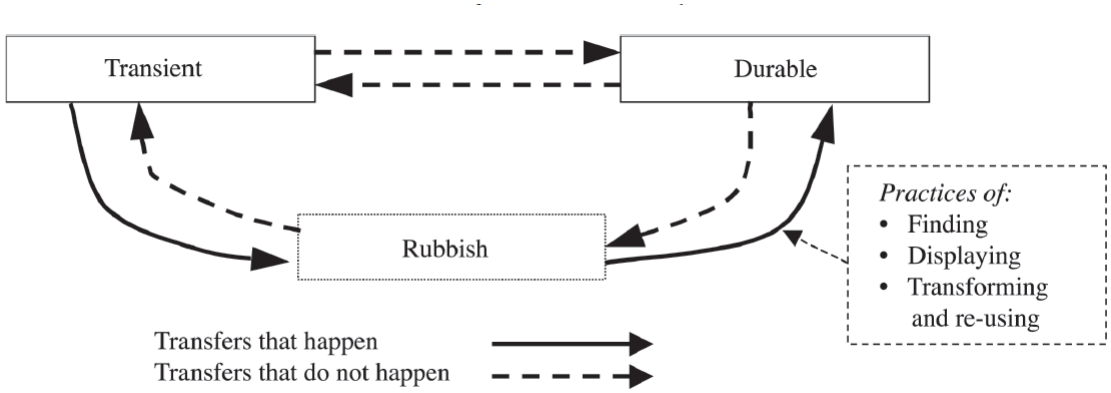

Figure 1 - Thompson's Rubbish Theory (1979) Lifecycle of items

This figure clearly indicates an item can be seen as important to the beholder and then turn into rubbish as time passes, however, that same item could later be seen as valuable and durable later in life. An example of this could include a dining buffet which has been passed down from family to family or a car that has broken down and one person cannot repair but another buys it for cheap and knows exactly what to do to fix the issue. These are simply general examples, but this theory is certainly applicable to the category of construction and demolition waste as reuse and recycling have been made more popular in recent years and will be discussed later in the findings.

2.7 Conclusion

Based on available literature for the above-mentioned countries it is evident that landfilling is the most common practice as it is one of the most affordable options, while other innovative methods of disposal do exist – even if just in theory – these methods would require countries to make significant changes that could cost them large amounts of money and investment into knowledge. If certain disposal methods would be beneficial in the long run, it would need to be proven very effective and would need to be a result of pressing environmental conditions for countries to make these switches.

CHAPTER 3:

METHODOLOGY

3.1 Research approach

The approach that was taken to conduct this research was in the form of qualitative research. Qualitative was best suited for this research as it is not based on large amounts of data and numbers that can be used in a comparative measure or percentage focused. This research is an assessment, thus, qualitative research is best suited to make an assessment.

3.2 Research design

This study aims to assess the disposal methods of construction and demolition waste in the south-eastern region of Johannesburg. The objectives of this study seek to assess current disposal methods in South Africa, through interviews and observation, compared to other countries through literature review, to determine whether they are sustainable or not, and finally to assess legislation and policy involved in construction and demolition waste management in South Africa. Therefore, this study will contribute to the literature on construction and demolition waste management in South Africa and the overall landscape of sustainability of our construction and demolition waste management.

3.3 Description of study area

The study area consists of the south – eastern region of Johannesburg, located in Gauteng. The area started flourishing in the late 1880s when gold was discovered in the area (Lukasiewicz, 2017), i.e. Gold Reef City. This region still shows an active mine shaft from a previous gold mine. The Witwatersrand hills had the richest gold deposits and quickly became known as Johannesburg (Lukasiewicz, 2017). As time went passed the mines eventually closed but the city evolved into the Metropolitan area that it is today continuously growing, (Harrison and Zack, 2012) and construction to keep building and improving the city has not ceased since.

This area contains not just residential areas that are expanding, but also industrial parks that expand as well. This area hosts a factory that recycles, and re-processes aggregate as well as is situated near various landfill sites, which can provide companies with cheaper disposal, however, in terms of distances, recycling should be a feasible possibility as well.

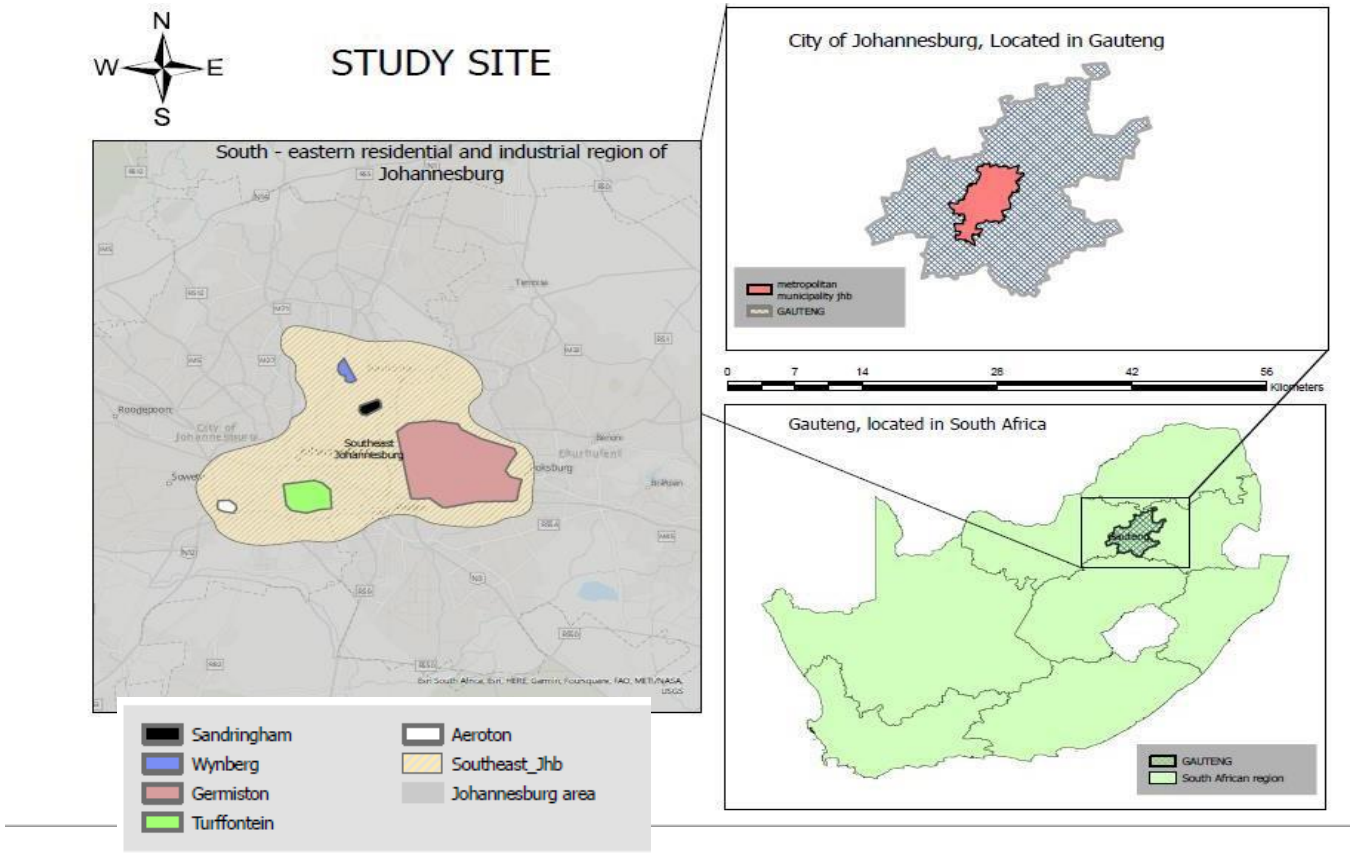

Figure 2 Map of study site - Southeast Johannesburg, Gauteng, South Africa

3.4 Study population and sampling procedure

Study participants comprised contractors on construction project sites, head office personnel of construction companies, on-site workers from construction companies, managers from factory operations that create recycled aggregate, waste management company officials and managers, and demolition company representatives as well as SHEQ officers. Multiple interviewees were involved in multiple ongoing projects and was able to provide insight on these different locations while many interviewees were interviewed on not only current projects, they are involved in but all projects they have been involved in, in the study area over the last 8+ years to provide perspective on how methods could have changed over the last few years. A minimum of one person from each of the above-listed categories were interviewed, which resulted in 20 interviews and the participants were selected from those who were willing, and the snowballing technique (Wilkinson and Birmingham, 2003) was used for the purposes of identifying key informants. The participants were not limited by race or gender and while the interviews were conducted, they were voice-recorded if the participant agreed and gave permission. Many interviews were conducted via Microsoft Teams as this suited some participants best with limited on-site interviews as companies could not provide access to walk around on site and take photographs due to the nature of the work. All participant information is anonymous to protect identity.

3.5 Research techniques and instruments of data collection

Below is a table that represents each method or instrument that was used to try and achieve the main objectives of the research project. Some appear more than once as they are multi-purpose and serve to achieve more than just one objective.

Table 1.1 – techniques and instruments used for each objective set out.

Objective	Techniques and instruments
1. Determine and compare current construction and demolition waste disposal methods used in South Africa and other countries.	**Field observation:** Field observation is qualitative in nature and contributes to the data that is gathered by other methods. Construction sites and landfills were visited to see first-hand how the waste is generated and treated thereafter; this contributed to a better understanding of current disposal methods. **The semi-structured interviews:** Interviews are resource-intensive as they require the researcher to set up a one-on-one meeting and they could be very long in duration (Wilkinson and Birmingham, 2003). The semi-structured interview was used as this provides the opportunity for flexibility so that

	the participant can answer relevant information; however, the researcher controls the questions being asked (Wilkinson and Birmingham, 2003). **Documentation:** Literature and other documentation based on how other countries dispose of their construction and demolition waste supplemented the data obtained through the other forms of data collection that are specific to the study area. This allowed a clear comparison of what other developing as well as developed countries are doing, compared to South Africa and if their methods could be applicable or not. The literature review provides a conceptualisation of the research through understanding and comparison.
2. Assess the sustainability of disposal methods and determine which would be most beneficial for longevity.	**The semi-structured interviews:** Interviews are resource-intensive as they require the researcher to set up a one-on-one meeting and they could be very long in duration (Wilkinson and Birmingham, 2003). The semi-structured interview was used as this provides the opportunity for flexibility so that the participant can answer relevant information; however, the researcher controls the questions being asked (Wilkinson and Birmingham, 2003).

	Documentation: Literature and other documentation based on how other countries dispose of their construction and demolition waste supplemented the data obtained through the other forms of data collection that are specific to the study area. This allowed a clear comparison of what other developing as well as developed countries are doing, compared to South Africa and if their methods could be applicable or not. The literature review provides a conceptualisation of the research through understanding and comparison.
3. Assess the current legislation and policy frameworks that dictate the disposal of construction and demolition waste in South Africa's solid waste management.	**Assessment of policies and legislation:** Current active policies and legislation regarding construction and demolition waste in South Africa, provided by the Department of Environmental Affairs, were assessed to provide an understanding of the governmental role of disposal and solid waste management in South Africa, while literature of some policies of other countries addressed in the literature review section. This assessment is essential to provide clarity on the legal requirements of construction and demolition waste disposal and has a focus on stakeholder involvement, requirements, and sustainability considerations.

3.6 Data analysis

Qualitative data in the form of interviews was used to conduct this research. The analysis of the data from the interviews contributed to the understanding of disposal methods of construction and demolition waste in the south-eastern region of Johannesburg. The responses from the interviews were organised thematically to try and find similarities in answers and find linkages between participant answers as well as discrepancies. Thematic analysis provided flexibility and could highlight differences and similarities in various responses of research participants (Nowell *et al.,* 2017). Once interviews were conducted, general themes were searched for in the transcribed date, and reviewed again before finally defining final themes whereafter the final analysis could be written up (Nowell *et al.,* 2017). Direct participant quotes used adds depth to avoid a flat descriptive account of themes and shows the data's richness (King, 2004). All data gathered during the data collection process is kept confidential and stored on a password-protected laptop and digital cloud storage which is email and password protected as well, and this was communicated to participants.

An assessment of current policies and legislation was conducted to determine the role of government in solid waste management of construction and demolition waste. The final data is presented by various factors of disposal methods and is able to identify which disposal option is the best in terms of sustainability, longevity, and finance through deduction and comparison.

3.7 Limitations of the research

The scope of this research was based on the south – eastern region of Johannesburg, in South Africa and the research was focused on any construction projects or waste disposal projects that the individual may have been involved in. The limitations of this research were the timeframe as it was carried out only by one single researcher, as well as limitations of facing gender stereotypes when seeking access to construction sites as it is a male-dominated field and many, if not most, sites do not provide access to people that are not essential to the project. Some companies were not willing to disclose certain information and thus, were not willing to be part of an interview while some also said they do not work with students and were also not willing to participate in an interview for this reason. The largest challenge was finding people willing to give up time for the interview. Financial challenges also played a role due to the petrol price and price fluctuations and the limited funding that came from the researcher alone. Finally, this study was based on a very niche market and the options within the study site were not many, therefore having people reject participation limited the amount of available participants.

CHAPTER 4:

RESULTS AND DISCUSSION

4.1 Introduction

This chapter consists of the presentation and analysis of results found by data collected and represents the different management techniques of construction and demolition waste in Johannesburg, South Africa. Thematic analysis was mainly used to connect the data gathered from the semi-structured interviews. Qualitative analysis in this form is helpful as it is generally used to identify patterns that exist within the bigger picture of all data collected (Ayres, 2008). The data depicts general trends as well as discrepancies found within the data that was collected. Not only will this chapter focus on the data that was collected but will also contain a policy analysis of governmental influence and involvement in the management of construction and demolition waste in Johannesburg. The results begin by presenting the socio-demographic characteristics of the participants.

4.2 Respondent demographics

Respondents varied from people who work at waste management companies, contractors for specific construction projects, environmental officers from construction companies, company owners of recycled aggregate companies and construction companies, demolition experts, and SHEQ officers. Respondents varied in age, gender, and race; however, most interview participants were Caucasian males.

Respondents ranged from being in the business for a minimum of four years up to thirty-two years. Thus, Table 2.1 presents the gender of the participants.

Table 2.1 Respondent gender.

Gender	Number of participants	Percentage
Male	17	90%
Female	3	10%
Total	20	100

There were only 20 participants to this study due to various reasons. The main reason for this number of participants is due to the type of market this study was based on. The study site itself was only a section of Johannesburg and the type of respondents for this specific research was based on experts in a very niche market that not a lot of people could partake in. The study site limited the number of companies in the area and not all were willing to conduct interviews. A large portion of the projects are also run by the same companies at multiple sites, and therefore there were not many options. Thus, these interviews could only involve a certain person and cannot be measured by the population size itself of individuals for the area, but rather on the number of companies who were willing.

Construction and demolition type of professions is quite a male-dominated field with the female participants being more involved in the environmental side of the interviews such as SHEQ officers or representatives of the environmental team. Most companies also provided their top management to participate in the interviews which made it evident that females are not on the majority side when it comes to management in this

industry. Out of the 20 participants only 4 were African and the other 16 Caucasian which indicates that the company management is held by Caucasian male as out of the African participants none were management level. Table 2.2 presents the number of years the participants have spent in the industry.

Table 2.2 Number of years in the construction industry.

Years in industry	Number of participants	Percentage
0 – 9	4	20%
10 – 19	3	15%
20 - 29	10	50%
30+	3	15%
Total	20	100

Table 2.2 indicates how long the respondents have been active in their current field and for some it does not include their years in the relevant field but only in their current job type. Having 15% of participants in the field for over 30 years provides insight into how much it has changed over the decades and even the significant change in the last few years. Only 20% have been in this industry for under 10 years and only 15% is less than 20 years. It is evident that the majority of the participants have been in the field for over 20 years and are the ones who have seen significant changes as they entered the workforce compared to now. This group is of value as they have a lot of experience and knowledge on the topic that they are able to share and have climbed the ladder to provide different vantage points. This could also explain why so many of

the participants are in management as they have been doing the work for so long. Table 2.3 reflects the percentage of participants in management and those not.

Table 2.3: Participant positions in the various organisations.

Position	Number of participants	Percentage
Management	9	45%
Nonmanagerial	11	55%
Total	20	100

The data presented posts an almost well-balanced differential between those who work in upper management such as those who own and are managers, and those who are the workers for the companies. This is important to distinguish as it reflects on companies in terms of who is aware of what. Some of the interviews were intentionally with waste management companies so all participants would be able to provide knowledge on what happens to the waste specifically and therefore level of employment would not matter, however, for companies such as construction and manufacturing the lower level employees would not necessarily know what happens to the waste if that is not their area of work, i.e. a site engineer might not know what happens to the waste as that is not his job description. In these instances, talking to the managers or the specific environmental teams would be necessary. It would also be in management's hands to employ waste management companies if their own company does not deal with it's own waste management directly, but outsources the job instead.

Management would also need to oversee that all certification for waste management is in place and they would thus have the knowledge to share during the interviews about what compliance needs to be followed. Table 2.4 indicates the number of projects the participants have been involved in during their time in the industry.

Table 2.4: Number of projects involved in.

Projects involved in	Number of participants	Percentage
1 – 9	5	25%
10 - 19	11	55%
20 - 29	4	20%
Total	20	100

The number of projects shown in Table 2.4 is important as it provides insight into how many times participants have had to deal with waste differently. Some of the participants are in specific fields where the waste management could have looked the same for every project, i.e. construction of buildings, whereas other participants could have had to adapt their waste management practices for different scenarios, i.e. waste management for different projects.

The majority of the participants at 55%, were involved in between 10 and 19 projects over their timespan in the industry. Even though they may have been in the industry for very long it is important to note that some construction and demolition projects take multiple years which could result in the number of projects they have been involved in being a lower number. Whereas a participant who has been in the industry for a shorter period of time could have more projects they were involved with as they might have overseen multiple projects at one time. While 25% of participants have been involved

in less than 9 projects and only 20% have been involved in more than 20. These projects differ in size and magnitude as well as type.

4.3 Data collected related to construction and demolition waste

Interviews were conducted as widely as possible within the field of construction and demolition waste as there are so many key factors and stakeholders that are involved. Participants were specialised in creating recycled aggregate, glass and all elements tied to glass, non-hazardous waste, and hazardous waste. Due to the nature of projects and expertise varying so much, it was able to determine the usual waste referred to was bricks, cement, wood, plastic, glass, soil, and objects involved in demolition of pre-existing buildings such as doorframes, toilets, panelling, lights, etc. It is important to note that the waste referred to only includes the building materials for the new project or that which is generated when a project is demolished and not the waste that is generated during the ongoing project such as worker waste including food, cold drink bottles, etc. Thus, Table 2.5 presents disposal methods and reasons for using specific methods. The percentages in the table indicate the percentage of participant responses in relation to the total number of participants and not a grand total of 100%, i.e. 20 out of 20 respondents indicated use of landfill and thus, 100% of respondents.

Table 2.5: Disposal Methods and Reasons for Using Specific Methods.

Methods	Responses	%	Reasoning
Landfill	20	100%	Cheapest
Recycling	19	95%	Dictated by law
Crushing into aggregate	14	70%	Cheapest
Incineration kilns	2	10%	Environmental concern
Total number of times various methods was mentioned	55	The percentages are based upon the 20 respondents and not a total of 55 responses.	

Table 2.5 reflects on the disposal methods that were brought up during the interview process with participants. Every participant noted that they make use of landfilling as a disposal method even if it is not for every project specifically and all mentioned that it is by far the cheapest option when it comes to Gauteng (multiple participants indicated that it is not the same situation for the Western Cape). Most of the participants except for 1 said they recycle what has to be recycled according to legislation even if they do not wish to do so because they are obliged to by law as some materials are not allowed to be taken to landfill. 14 Participants indicated that they either crush materials directly on site with mobile crushers to create recycled aggregate to be used again on site, or that they send some waste to be made into recycled aggregate or just buy recycled aggregate to use on their sites. Lastly, only 2 participants even mentioned the use of incineration kilns as an environmentally friendly option that they use only every now and then because it is very expensive and must

be at the client's request. Figure 3 below shows a visual representation of these options.

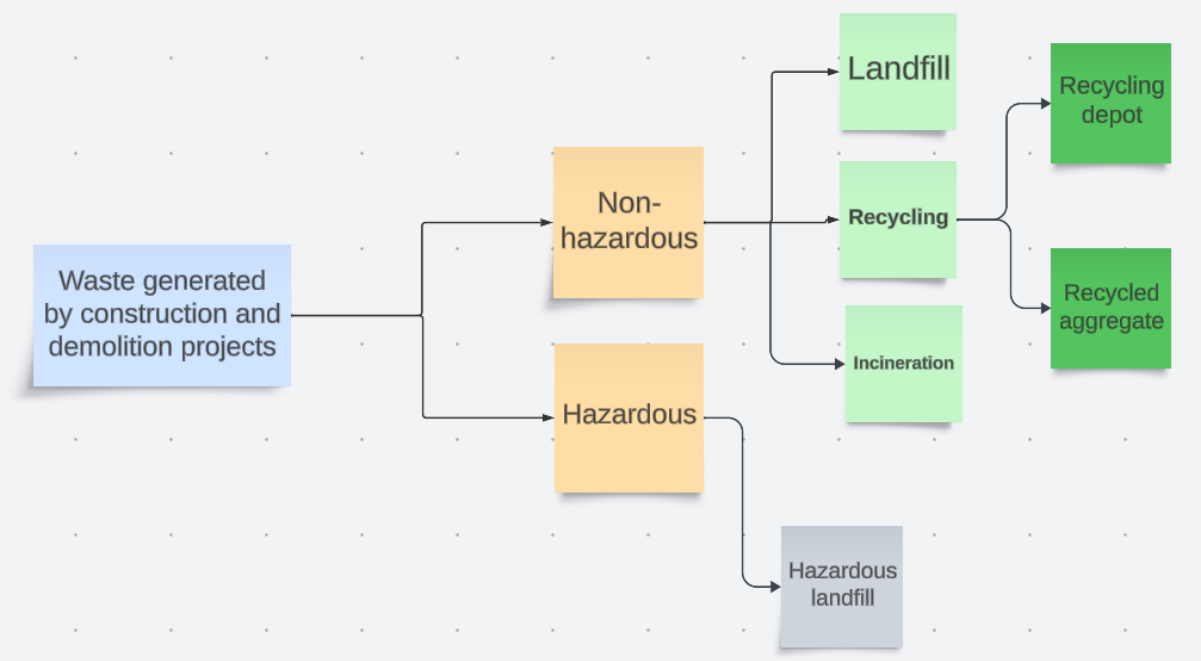

Figure 3 - Construction and Demolition waste disposal options

Figure 3 represents the options in a flow chart on how the participants deal with their waste. The first question needs to be whether the waste is hazardous or not to determine the next steps. However, most of the waste generated in these projects is not hazardous and thus, participants only mentioned that type of waste is treated differently and sent to a landfill that is specific to hazardous waste. Regarding non-hazardous waste, the disposal methods that were used most frequently included landfilling and recycling, or crushing product into recycled aggregate, with minimal reference to other methods such as incineration.

It was unanimous that landfilling is the cheapest option for waste disposal in Gauteng as landfills only charge about R700 per tonne of waste to dispose according to participants, while all interview participants agreed that they recycle the waste

products that are not allowed to be disposed of by landfill and some that they try to recycle as much as possible. Many participants that have direct contact with the client who is having the construction or demolition done, indicated that most clients are not willing to pay extra for environmental conscience and only want the cheapest option. One of the participants from a construction company commented:

> "*Money makes the world go 'round and all these other options such as recycling and incineration are unfortunately the more expensive option and that is the one the client usually does not go for*".

While multiple participants also indicated that your larger scale clients are willing to pay a bit more for sustainability throughout the entire construction project as that is the way these clients can obtain something called a "Green star rating", which is a rating that is used to scale how sustainable a building is from construction all the way to operationality. The clients who see this rating as important are more willing to have projects that are zero waste to landfill and pay the extra costs involved with recycling and incineration.

It was evident during interviews that, those who mainly work in construction specifically, do not think too much about the waste they generate and simply hire external companies to deal with the waste and do not know what happens to the waste once it leaves their premises. A participant who works solely in construction mentioned: *"I do not know what happens to the waste, we just sort it and the waste companies come and remove it."* This quote is also very similar to what some other participants mentioned when asked about their waste management.

However, waste management company representatives insisted during interviews that they provide certificates to show how the waste was dealt with and disposed of. During

an interview with a participant who works for a waste management company, the following was said:

> *"During the planning process, we indicate exactly how we will deal with the waste from start to finish and then we generate certificates for the construction companies."*

The following section (4.3.1 – 4.3.6) below is the analysis of the themes that emerged from the data.

4.3.1 External factors that play a role in choosing disposal methods

As mentioned in a quote by a participant – it is all about money. A discussion that kept coming up during the interview process was that of fuel to transport the waste. With fuel prices that see an increase and decrease constantly throughout the year, it is difficult to keep up. Participants indicated that when a project is far from a recycling plant or incineration kiln, that is very rarely used as a disposal option as the drive to these plants is too far and the cost of fuel does not allow it. A direct quote from a waste company representative:

> *"We try our best to offer these options to clients but based on travel it is not the best outcome to drive to the incineration kiln or recycling plant, but sometimes the recycling is actually closer to the project site, and driving there works out all the same as having to pay less for landfilling."*

Some participants indicated that clients are a bit more prone to sustainability when the options can come to them, which is where portable crushers and recycling stations come in. A participant who specialises in sustainable waste disposal mentioned that

they can hire mobile crushers to come on-site and create recycled aggregate, and these clients are much more willing to make use of such options because fuel does not play a role.

A participant who owns a smaller-scale construction company mentioned that most waste goes to landfills except for things such as asbestos with the main reason being: *"People can get sick from it so we just ensure their safety."* Which is more of a labour concern than waste management concern. This could result in large amounts of waste ending up on dumps and landfills if many small businesses operate this way.

4.3.2 Landfill use implications

A large discrepancy found in interviews was how companies work with landfills. Some participants have a standing arrangement with landfills to ensure that their fees stay the same and rarely see any increases during the time they use the landfill to dispose of waste. Other participants indicated that using landfills are very informal and you can simply show up with your waste to dispose of it with them, while some participants indicated their company actually owns a landfill and therefore, they also just show up with the waste and dispose of it there. Below are some quotes from a variety of respondents in various industries involved on their landfill use:

> *"There are no contracts involved in making use of landfills. You just call them and arrange a drop-off."*
>
> *"Sometimes we have standing arrangements with them that we will bring our waste to them for x amount of time, but that cannot guarantee us a fixed price, but it won't fluctuate too much that way."*

"It depends whether or not the landfill site is municipal or if it is owned by the private sector. They are different and operate accordingly."

Most waste that is generated and disposed of during construction and demolition projects are non-hazardous, however, some waste is hazardous, albeit to a small extent that needs to be treated completely differently from non-hazardous waste. These types of landfills need to be monitored for about 25 years after the landfill has closed down to ensure there are no leaks and that the soil quality has not been affected. Below is a quote from one of the higher-up positions for a waste management company who needs to be compliant with hazardous waste and up to date on use of hazardous landfills:

"We are still monitoring a landfill every year that has been decommissioned 24 years ago to ensure the landfill has not contaminated the surrounding soil. That is money and man power you have to give for a long time after not being able to use it anymore."

4.3.3 Participant perceptions on government involvement

Frustrations ran high when it came to questions about governmental involvement and legislation. Most participants indicated that the government is quick to make legislation regarding waste but does not offer the infrastructure to accommodate these acts and amendments. When asked regarding this, these were some answers from multiple participants in various fields of interest involved in the study:

"They are quick to make policies around recycling but do not build recycling plants to implement these policies."

"They want to follow suit with all these other countries but do not actually implement all these things that are just put on paper."

"We can talk and talk and talk but if nothing ever gets implemented, we are wasting our breath."

There was also widespread difference when asked if government ever checks whether or not companies are compliant with policy and legislation. A few participants indicated never having ever been checked on by the government if they are compliant with their waste management while others mentioned that they get audited but not without warning while two indicated that government officials have shown up without warning to check in on their compliance. This varies quite in response and is an indication that government officials might be spread too thin and can only check up on larger or more mainstream projects perhaps.

An environmental department manager said: *"They are called the green scorpions, and they can come and check your operations at any time."* But specifically said they receive notice before the officials show up.

A participant from a different field involved in site projects said: *"You get audited on waste management and sometimes they can show up without notice at any time."* Which is contradictory to the previous quote.

A contractor who manages smaller-scale projects said: *"No one has ever visited our site to check if we are doing the right thing."* This is also completely different from the previous two in experience, therefore it is difficult to know why some projects are worth checking in on and others not.

There were, however, cohesive answers when asked about the repercussions if you are found to be out of line with legislation. Repercussions mentioned by everyone were the same and included very large fines the company would need to pay, stopping operations if the issues are quite large and companies would be given a timeframe to sort the issue out and can only continue operations once a second inspection is conducted and satisfactory, and even jail time should the situation be extreme.

4.3.4 Change in waste management over time and participant perceptions thereof

A large portion of the interview participants had been in the industry so long that they were able to tell how the disposal of construction and demolition waste has changed over time. It is unanimous among those participants, that in the past everything was simply sent to landfill and only in the last +/- 8 years has a shift come in to try to dispose of construction and demolition waste more sustainably. A top-level manager for a waste management company who has been in the industry for over 30 years said:

> *"When I started out we just dumped everything at landfills because that was the easiest as well as cheapest way to dispose of the stuff. Only a few years ago did we see some more complicated policies coming out on how we have to deal with waste and being told that certain things cannot go to landfill anymore. The process of dealing with hazardous waste has also become extremely complicated."*

Another participant who has been in the construction industry for more than 20 years said: *"We were never bothered about sustainability and the environment. We just knew that we could send everything to landfill and that's that."*

Each interview participant was asked if they could see *anything* implemented in our waste management in South Africa and money was no object, what it would be. The answers varied and only a small handful of people were on the same page about using waste to generate electricity – which would be very helpful in South Africa as we need one and are in excess of the other. A participant from a waste management company indicated: *"If we could use waste to generate electricity that would take pressure off of coal suppliers as well as clean up our environment."*

Other answers included more recycling plants to make it more affordable and even formalising informal waste pickers to help with recycling. A participant in the sustainability department said: *"They are already recycling. Even though they are doing it for an income and not necessarily the environment, it is still being done. This way we help the environment, and they can make a proper income and more people could do it."*

Only a few participants indicated that they have never thought beyond doing what is currently being done. There was also participant from a waste management company mentioning that South Africa is not as far behind more developed countries than some might think: *"South Africa is doing quite well when it comes to recycling and has the methods, it is just implementing these methods that are not always possible due to cost."*

4.3.5 Overall sustainability and participant perceptions on sustainability

Most participants indicated that their companies do practice sustainability in some form or another, however, it is clear that for some of them, it is simply due to legislation and

not their own accord, while others are actively working towards a sustainable future for our waste management. The waste management companies take certain steps and try to provide clients with all possible solutions for their waste management which include the most sustainable options, even if clients do not choose those options at the end of the day. An interview participant who works for a company that specialises in making sure the construction and demolition projects' waste is dealt with sustainably said: *"Landfilling is our absolute last resort. We try everything before it has to come to that."*

Most participants indicated they try their best to reuse waste for projects where there are items that are in good condition and can be used by someone else or even try to reuse these items themselves. Two participants from different construction companies said:

> *"We open the opportunity for people within the company or project to claim these items before we deal with them as waste."*
>
> *"We try to use as much of the waste from projects on the next project if the items are in good enough condition."*

However, it is noteworthy that we live in a country where informal settlements would be most grateful for second-hand items such as toilets or doorframes to better their informal housing, but it would be difficult for these companies to decide who would be able to get these items and how would they keep the situation as fair as possible.

There were participants who saw sustainability as a hindrance to their day-to-day job and said that sending all the waste off to landfill is just the easiest way to dispose of the waste and think they should not be the ones to worry about waste being dealt with sustainably. A small-scale construction company owner said:

"I own a small construction company and do not have the manpower to look at all these options. I have to take care of the waste myself and due to deadlines, I often have to dispose of the waste after work hours and just want to go home. Let these big companies do all that."

Another participant from the construction industry also saw sustainability as a hindrance and said: "*Sustainability is nice and all, but it is just not practical and always feasible."*

However, some companies that do not focus so much on sustainable waste disposal itself do try other ways of sustainability including making use of recycled aggregate which is made from construction and demolition waste. Therefore, they are applying a certain level of sustainability during the construction process. Finally, some participants indicated that there are larger issues to worry about as a country and that the country is simply not geared towards sustainability right now even though it wants to be. A participant from a construction company mentioned:

"There are bigger problems that the country would need to address before being able to give money and infrastructure towards something like sustainability. They like to put these things into policies but overall don't have the means for it to become truly sustainable soon."

4.3.6 Comparison to more developed countries

The data gathered indicates that South Africa does not make use of any special disposal methods that are specific to South Africa alone and landfilling, reuse, recycling, recycled aggregate and incineration kilns are all methods that are used

internationally as well. The only other method that was mentioned during interviews was the methods of using waste to conduct electricity, which is a complicated process and requires very expensive infrastructure that only more developed countries that are focused on sustainability can afford.

4.4 Policy Analysis

4.4.1 Introduction

Legislation and policies in South Africa regarding construction and demolition waste must be analysed to determine government involvement in its management. Most legislation and policies stem from NEMA[1] and NEMWA[2] as they are the main acts that provide environmental management and have been amended multiple times over the years to accommodate the growing population, economy and understanding of environmental management. The analysis will consist of general policy and legislation in South Africa as a whole, as well as any available documentation if there is any, that is specific to the municipalities of the City of Johannesburg and the City of Ekurhuleni, as there is an overlap between the two municipalities over the study site. The analysis is required also to determine if the government is keeping up with new trends, findings, and technology regarding waste management that has come about in the last 25 years since NEMA was created.

[1] Department of Environmental Affairs and Tourism. 1998. National Environmental Management Act, 1998 (Act no 107 of 1998). Government Gazette, 1540:401, 27 November 1998.
[2] Department of Environmental Affairs and Tourism. 2009. National Environmental Management: Waste Act, 2008 (Act no 59 of 2008). Government Gazette, 278:525, 10 March.

4.4.2 Analysis of policies in South Africa relating to waste

To truly have a comprehensive overview of policy and legislation in South Africa it is necessary to start at with the document that started it all – The National Environmental Management Act of 1998 (Act no 107 of 1998). This document was the start of what we know today as policies and legislation when it comes to all matters that concern our environment. The act sets out principles and institutions, along with forums and committees and it truly was the starting point that moulded many times over the past decades. It sets out environmental management plans along with how they will be enforced and how disputes will be sorted and does not just set out to protect the environment but protect those who are involved and those who are referred to as "whistle-blowers" (people who report those who are not compliant with the act and are damaging the environment). Finally, the act looks at the administrative side for the new approach when it comes to taking care of the environment moving forward as was not done in the past (Department of Environmental Affairs and Tourism, 1998). Regarding waste itself, the act is not too specific other than it setting the ideal of minimising waste or disposing thereof in a manner that is responsible and that all should have access to information on waste. Therefore, the original NEMA Act[3] does not have much analysis to be done on this specific research.

10 years after the publication of NEMA, a Waste Act (Act 59, of 2008)[4] came out which is much more important and relevant to this study. This Act focuses on waste alone and is an introduction to all types of licenses that are required when it comes to waste

[3] See footnote 1 on page 43.
[4] See footnote 2 on page 43.

management activities today. It sets out all definitions of waste and waste particulars extensively and introduces national waste management officers chosen by the minister for the national government. It differentiates between waste generators of priority and general public and introduces a section that is specific to a more circular type of economy with the 3 R's of waste (reduce, reuse, recycle). The Act specifies how waste should be stored and transported, treated and disposed of. When looking at construction and demolition waste specifically, the Act includes this type of waste under their "general waste" classification and thus, does not make specific reference to it (Department of Environmental Affairs and Tourism, 2008). For most sections the Act sets out in the beginning before industrial waste, there is a closing section that places focus on the "consequences" of not adhering to the above-listed section, however, those consequences do not refer to physical consequences as what would happen if one were to be in clear violation of these rules. It simply states along the lines of "No person may…" and lists the particulars. Only towards the very end of the Act is any type of penalty visible in a small section that could easily be overlooked. This section also does not provide any particulars on who would be the one to check in on projects or who would be the deciding factor on which penalty would be suitable.

Four years after the Waste Act (Act 59 of 2008) was published, there were amendments to it and waste management seemingly got more serious in this time period. Between 2012 and 2014 the following Acts were published: the Waste Classification (2012)[5] which was amended again (2013)[6], National Waste Information

[5] Department of Environmental Affairs. 2012. National Environmental Management: Waste Act, 2008 (Act no 59 of 2008): Waste Classification and Management Regulations (Notice 614). Government Gazette, 35572:39, 10 August.

[6] Department of Environmental Affairs. 2013. National Environmental Management: Waste Act, 2008 (Act no 59 of 2008): Waste Classification and Management Regulations (Notice 634). Government Gazette, 36784:3, 23 August.

(2012)[7], Landfill Standards (2013)[8] and finally, the Waste Act itself was amended once again in 2014[9].

The Waste Classification (2012&2013) introduced classifying waste into separate categories along with keeping records of waste on a system. Here it can be seen that construction and demolition waste is still classified as “general waste” unless it now contains anything hazardous, where it will then fall under hazardous waste. The generator of waste must classify all waste within 180 days of generation and cannot store the waste longer than 18 months (Department of Environmental Affairs, 2012). Transporters of waste may also not take any waste that has not been classified yet, and all the waste that is not hazardous may go to landfill. The recording of waste generated comes into action in this period and these recording must reflect various factors such as classifications, quantities, the 3 R’s and who the generator was and this information should be kept for 5 years, in case of an audit that can take place. The Act not only places emphasis on the waste generators but it is clearly placing focus on anyone who transports waste and provides them with as much guidelines as those who generate and there starts to be differentiation in roles when it comes to waste – those who generate, those who manage and those who transport. Toward the end of the Act there is a small section on offenders, and it very vaguely states that imprisonment or a fine could be consequence for non-compliance, however, it does not state an amount of time for imprisonment or money for the fines or who decides

[7] Department of Environmental Affairs. 2012. National Environmental Management: Waste Act, 2008 (Act no 59 of 2008): National Waste Information Regulations (Notice 625). Government Gazette, 35583:3, 13 August.

[8] Department of Environmental Affairs. 2013. National Environmental Management: Waste Act, 2008 (Act no 59 of 2008): National Norms and Standards for the Assessment of Waste for Landfill Disposal (Notice 635). Government Gazette, 36784, 23 August.

[9] Department of Environmental Affairs. 2014. National Environmental Management: Waste Amendment Act, 2014 (Act no 26 of 2014). Government Gazette, 449:588, 2 June.

the final fate. In the amendment that was published a year later there are numerical values added to this section (Department of Environmental Affairs, 2013).

In the same year, the National Waste Information Regulations (Notice 614 of 2012)[10] was published. This document placed focus on waste generators needing to register on the South African Waste Information System (SAWIS) and sets out all criteria that need to be reported and how they must be reported to regulate information and data collection (Department of Environmental Affairs, 2012). To make use of this system it is noted that one would need to apply to register, however, with backlogs and longer periods where waste generators are not logging their information on the system, this could potentially lead to timeframes where waste disposal is not being correctly done and creates a reliance on manual record-keeping of companies if they were to be audited which might not even happen. This document is one of the first documents that recognise construction and demolition waste on its own and classifies this waste as a major waste type, rather than putting it under general waste (Department of Environmental Affairs, 2012).

A year later we find the National Norms and Standards for the Assessment of Waste for Landfill Disposal (2013)[11] published. By this stage we see more strict rules when it comes to what exactly is being disposed of on landfills. The document provides methodological approach to how waste that arrives at landfills for disposal will be assessed to determine factors such as chemicals, concentrations, and leachable substances that could end up in the soil. The document was hard on timeframe and dictated that these processes need to be occurring all over the country within three years of the publication of the document. It lists all compounds that could occur and

[10] See footnote 5 on page 45.
[11] See footnote 8 on page 46.

provides their acceptable and non-acceptable measurements (Department of Environmental Affairs, 2013). The document is quite comprehensive and clear on what is allowed and what is not, however, this may have required some trail and error in the beginning phase as the average person would struggle with the chemical layout and measurements and would need a professional to ensure their waste is within ranges and boundaries.

A large problem with much of the legislation around waste management is that it relies on the honesty of people. Categorising waste, logging waste and disposal methods and keeping records all rely on people and could also only involve single streams of people that could fake documentation or just sign that it was disposed in a manner which is deemed appropriate. For larger scale waste generators it involves more streams of people that could limit chances for fraud, however, smaller scale waste generators can still slip through the cracks. Some of the language used is also not necessarily easily understandable to the common man. The sentences could be somewhat ambiguous or could even be misunderstood which forces companies to have persons of higher education to look over these documents and ensure compliance, that sets smaller companies back financially.

In 2014 we see the Waste Act (2008)[12] amended. This amendment saw large focus on making the waste act clearer and trying to eliminate ambiguity by being much more specific on certain fronts such as not simply saying “Minister” but rather mentioning the specific minister who is involved in that section as well as defining terms such as “re-use” and “waste”. We see a large shift in accountability switch over to the department as most amendments is to include them in steps and management roles.

[12] See footnote 9 on page 46.

This is where financial provisions on waste are finally introduced and it is clear how the cost of all these implementations that have been suggested in the last six years will be funded. The establishment of a Bureau of Waste Management also comes into play in this document stating that the Minister may only make any amendments to policies once the bureau has also overseen and approved the changes (Department of Environmental Affairs, 2014). This bureau also mainly takes over waste management as most of the roles and responsibilities here fall into their hands. The differentiation between the chief executive and employees are set out clearly as well as the regulations the bureau needs to follow. This amendment becomes very specific on classification of waste and it is noticeable that construction and demolition waste are carefully taken into consideration in multiple categories and listed options as sub-categories. The classification falls under hazardous in multiple listings as well as general waste that is not seen as hazardous but still very specific to all items that would fall under building and demolition waste (Department of Environmental Affairs, 2014).

In April, The Minister (Department of Forestry, Fisheries and the Environment, 2023)[13] invited the public to provide inputs and comments to amendments to these policies, therefore they could certainly look different yet again in the near future.

4.4.3 Analysis of policies by municipalities of study site

[13] Department of Forestry, Fisheries and The Environment. 2023. National Environmental Management: Waste Act, 2008 (Act 59 of 2008): notice of extension of commenting period on the proposed amendments to the Waste Classification and Management Regulations, 2013, the National Norms and Standards for the Assessment of Waste for Landfill Disposal, 2013, and the National Norms and Standards for Disposal of Waste to Landfill, 2013. Government Gazette, 48456:694, 21 April.

The City of Ekurhuleni Metropolitan Municipality does not have any open policies regarding environmental protection or waste management available on their local website, they do however, provide contact details of the environmental management department of the municipality so one could easily ask for these documents and hope for a response. It was not surprising that the municipality could not respond to emails asking for this documentation as it is clear that anyone who goes to the website is able to contact them directly, which means they would be receiving hundreds of emails per day that they need to tend to while simultaneously having to do their jobs as well.

Thus, no specific documentation from the city of Ekurhuleni Municipality was provided and only governmental documentation such as Acts and policies are available for analysis.

The City of Johannesburg Metropolitan Municipality provides an environmental management policy (City of Johannesburg, 2005), that includes waste management, openly on their website[14], however, this has not been amended since 2005 and is the only available document of this nature. They are not as transparent as the city of Ekurhuleni Metropolitan Municipality about who oversees environmental management or waste management and do not provide any contact details to these individuals. The website itself is also lacking general documentation such as policies and procedures, thus they either do not stray too far from government legislation and maintain NEMA[15], NEMWA[16] and their amendments, or they do not update their website often enough to publish more documentation of their own.

[14] City of Johannesburg Metropolitan Municipality. 2005. Integrated Environmental Management Policy. Available from: https://joburg.org.za/documents_/Pages/Key%20Documents/other/policies/Environment/Environment.aspx.
[15] See footnote 1 on page 43.
[16] See footnote 2 on page 43.

The integrated environmental management policy provides some insight into Johannesburg as a city, looking at population and history, as well as some targets that the city set out to accomplish such as the Millenium Development Goals and the Johannesburg Plan of Implementation (page 7), while some elaboration on these goals are provided in the annexure in this policy. The policy was created with sustainability in mind and was compiled with the idea of setting realistic goals for a sustainable future (page 8), however, as mentioned earlier, this policy was set in 2005 and the landscape of what needs to be done to achieve sustainability over the last 18 years compared to now would look vastly different in not just scale but landscape as well (City of Johannesburg, 2005). The structure of the policy laid out on page 9 thereof indicates that many of these goals were set with 2030 in mind but should be reviewed in future, while 2030 is a mere 6 years away and there has been no update on this policy. The vision for the policy on page 15 indicates environmental quality improvement in water, air, landscape, biodiversity and waste reduction.

The key theme that requires analysis is the waste management section of the policy and how the City of Johannesburg Municipality specifically views waste management and the implementation thereof. The policy is divided into themes and theme 5 on page 23 is waste management. Even in 2005 when this policy was created there was recognition that too much waste is added to landfills and that the three R's were not being practised widely enough and showed very low numbers for recycling. The policy also identified that The Polokwane Declaration required a reduction in landfilling as a waste disposal method (City of Johannesburg, 2005). The final document that is published on the municipality's official website is incomplete as seen on page 24 when the section that is supposed to indicate targets on waste reduction, do not indicate all targets and have complete sentences or percentages. Nowhere does this policy

specify types of waste and thus it is not possible to know whether they identify construction and demolition waste as a problem with landfill.

The implementation of these goals appears on page 32 identifies committees that will be in charge of these programmes, and the roles are set out in Annexure 1 that shows theme 5 for waste management from page 40 – 42[17]. These tables that indicate the plans and programmes for waste management issues are quite unclear and mostly do not indicate how any of these goals will be achieved but are rather more of an outline of what the problem is and which team needs to be involved in these actions. There also seems to be no external role players mentioned meaning that they were not open to public or private sector help during the setup of this policy. It also mentions some strategies that could prove very difficult to implement such as fines for people who dump illegally (City of Johannesburg, 2005), however, being able to monitor something like that would consume many resources that the city might not consist of.

Overall, the policy seems rather incomplete and could have contained much more information and avoided blank spaces. If the intention was to draw from NEMA and NEMWA there could be more reference to the acts and their specific sections on waste management in the required section in the policy, rather than a quick mention at the start. Each section that is discussed is also quite short and kept to the bare minimum of information, while stating problems and not efficient or clear ways to tackle these problems. There is also reference to certain documentation here and there that are nowhere to be found on their website.

[17] See footnote 14 on page 50.

4.5 DISCUSSION

This study aimed to assess the disposal methods of construction and demolition waste in South Africa. It further sought to understand the landscape of construction and demolition waste management in South Africa compared to other countries, along with the sustainability thereof and the specific policy and legislation involved. This section interprets and critically evaluates the findings of this research and the significance of adding to existing literature on the topic. The section also includes the limitations encountered in this study. It is important to reiterate that this discussion and evaluation is solely based on construction and demolition waste management and does not consider general waste management.

The research questions that were set out at the beginning of the study are:

I. *What are the current disposal methods of construction and demolition waste used in South Africa and how does it compare to other countries?*

II. *Which of these methods is a more sustainable option to use?*

III. *What part do legislation and policy play in the disposal of construction and demolition waste in South Africa?*

Based on the results of the data collected the main themes identified for discussion to reflect on the research questions are:

I. *South African waste disposal methods compared to other countries.*

II. *Waste disposal method changes and policy analysis compared to implemented methods.*

III. *Waste disposal longevity for future methods and sustainability*

4.5.1 Reflection of *waste theory* framework connection to data

The theoretical framework for this study came from Thompson's Rubbish Theory (1979). The theory essentially follows the concept that "one man's trash is another man's treasure". In the case of recycled aggregate, this is certainly the case as construction companies or companies who do demolition projects see the waste generated as something that needs to be disposed of while companies who make recycled aggregate can use that waste to generate an income as well as minimise impact on the environment. Creating recycled aggregate has only come into play in the last decade or so and the market therefore is still not what it could ultimately be, some have their reservations about buying the aggregate as they feel it may have lost some of its structural integrity in comparison to other forms of aggregate.

Materials that have not been damaged that are given to people to reuse (toilets, doorframes, etc) are also often seen as a burden to deal with, however, those people who receive the items are truly grateful for them. For some of these items it could complete the full lifecycle as indicated in Figure 2 in Chapter 4, that the item is seen as transient in the initial construction process but as time passes and the building gets demolished or simple renovation occurs the item could no longer be seen as possessing value, yet if the site is opened up to workers or even the surrounding community the item could be seen or transformed back into durable. A different example could include a brand new transient item that was supposed to be installed during the construction process gets slightly damaged and no longer fits in the aesthetic of the project it is seen as rubbish. However, the damage done could be so

minimal that another does not see the damage as detrimental and could still make use of the item in a different way or setting, making the item durable once again.

Various other materials that are disposed of in landfill may be seen as rubbish for the next few years, but as time progresses more categories of items could be seen as valuable and would not need to go to landfill.

4.5.2 South African waste disposal methods compared to other countries

Table 3.1 Comparison of South African disposal method to other countries.

COUNTRY/REGION	MOST COMMON DISPOSAL METHODS	LACKING CLEAR POLICIES AND LEGISLATION	INNOVATIVE TECHNIQUES AVAILABLE	SOURCE
SOUTH AFRICA	Landfill, recycling, incineration kilns	✓	×	(Ding *et al*., 2018; Fitchett & Rambuwami, 2022) Also based on data*
UGANDA	Landfill, burning waste, illegal dumping, incineration kilns	✓	✓	(Balcom, *et al.,* 2021)
NIGERIA	Landfill, recycling, reuse	Not specified*	✓	Nigeria (Ogunmakinde, *et al.,* 2019)
ETHIOPIA	Landfill, recycling	Not specified*	✓	(Genet, *et al.,* 2021).
PHILIPPINES	Landfill, recycling	✓	×	(Estrada *et al*., 2023)
INDIA	Landfill, illegal dumping	✓	×	(Ram & Kalidindi, 2017; Sekhar *et al*., 2015; Jain *et al.,* 2020)

BRAZIL	Landfill, illegal dumping, minimal recycling	✓	×	(Brazil, 2002)
COSTA RICA	Landfill	✓	×	(Abarca-Guerrero *et al.,* 2022)
KUWAIT	Landfill	✓	×	(Albeeshi *et al.,* 2017; Al-Raqeb, *et al*., 2023)
CHINA	Landfill	✓	Experimenting but not yet implemented*	(Wang *et al.,* 2021; Yu *et al.,* 2022)
MIDDLE EAST	Landfill, illegal dumping	✓	Still in planning phase*	(Ibrahim, et al., 2022)
EUROPE	Minimal landfill, recycling, reuse, recovery	×	Not specified*	(Spišáková,*et al*., 2021)
US	Each state varies*	✓	Not specified*	(Aslam, *et al.,* 2020)

SOURCE:

Table 3.1 solely focuses on countries that were identified in the literature review section of Chapter 2. It compares the different countries' disposal methods along with policies and legislations in place. The table does, however, make generalisations of the countries with more specifications that can be found in the literature review, i.e. Delhi has some different operations than India as a whole, while the table only refers to India.

Based on a comprehensive literature review on construction and demolition waste management practices in other countries in comparison with the data collected during this study, it can be suggested that South Africa could make use of some more innovative ways of dealing with construction and demolition waste. Rather than simply disposing or recycling as most of the data shows but create different alternatives such as the roof tiles that were seen as waste were repurposed in incineration kilns in Uganda (Balcom, *et al.,* 2021) for example. If there are any projects such as this in Gauteng, they are not big enough to have caught the attention of the media yet. In India (Ram & Kalidindi, 2017; Sekhar *et al*., 2015) as well as Nigeria (Ogunmakinde, *et al.,* 2019) many items from the construction and demolition waste get recovered and sold on the secondary market. If this could be implemented in Gauteng, it could change the waste landscape as we have millions of people living in informal makeshift homes that could greatly benefit from a few extra bricks or other materials at a fraction of the cost compared to new items. Much like South Africa, Ethiopia also makes use of recycled aggregate for pavements and roads (Genet, *et al.,* 2021).

South Africa faces some of the problems stated by other countries such as Brazil concerning landfill sites that are far away and could easily lead to illegal dumping

(Rosado *et al.,* 2019), especially with constantly rising fuel costs. A Costa Rican study categorised barriers to recycling and the technical, social, and financial categories (Abarca-Guerrero *et al.,* 2022) apply to the data collected. Finances are a large reason why people do not recycle as indicated in Table 2.5 in Chapter 3, and was mentioned by nearly all participants of this study as it is more costly than landfilling. This data is supported by the information on Kuwait (Albeeshi *et al.,* 2017) that indicated alternatives to landfills hike up production costs too much. The social barrier comes into play as the management of construction and demolition waste is dictated by people who either *need* to be concerned about factors such as 'green star ratings' and would go the extra mile to recycle or those who do not need these ratings and want to get the job done quickly and cheaply. Finally, the technical barrier is applicable as the data indicated that there are not many recycling plants to make use of machinery such as on-site crushers to make recycled aggregate is not available to all and the complaint of government not providing recycling plants adds on to the frustration from participants.

With South Africa being so dependent on landfills, the question of whether we will follow in the footsteps of Uganda, who keep sending waste to landfills that have already reached their capacity when our landfills have reached the end of their lifespan, that multiple research participants indicated, is sooner than we think.

4.5.3 Waste disposal methods changes and policy analysis compared to implemented methods

The data supports the notion that in the past all construction and demolition waste was simply sent to landfill, while recycling and reuse only became more important in the

last few years. Legislation is in the process of moving towards gearing up for a more circular economy, however, the general complaint found in the data is that the government would need to supply the methods to support these policies with regards to reducing, reusing, and recycling - which they are currently not.

It is important to note that South Africa is continuously moving towards gearing legislation and policy more and more towards construction and demolition waste management and there are various attempts to move towards sustainability. Regardless of how flawed they might come across and are criticised by relevant parties. While multiple other countries as indicated by Table 3.1, do not have proper policies in place and this seems to be the main complaint nearly across the board. Including India (Jain *et al.,* 2020), Brazil (Brazil, 2002), China (Wang *et al.,* 2021; Yu *et al.,* 2022), and much of Sub-Saharan Africa (Muheirwe, *et al., 2022*), which leads to large amounts of illegal dumping and secondary market selling. The US (Aslam, *et al.,* 2020) and Brazil (Rosado *et al.,* 2019) are in the same position of government not wanting to take on too large of a role when it comes to construction and demolition waste, and it is agreed that the management thereof should be in the hands of the waste generators or much smaller governmental level.

As indicated by the policy analysis, the legislation is not so much geared towards the management of construction and demolition waste in specifics but rather provides a more general approach to waste management. Construction and demolition waste is attributed to being the second largest producer of general waste (Department of Environment, Forestry and Fisheries, 2020) in the country, yet it does not convey its category of policy. This could lead to various interpretations of the management of construction and demolition waste; however, the Minister has invited stakeholders to provide input in 2023 on updating various of the policies and Acts discussed in the

policy analysis that would hopefully provide more specifications to this waste in particular.

The data suggested that it is also not always realistic to try and legislate sustainability as words need to come with actions which, indicated by most participants, is not the case. The only consistent correlation between the data collected and the policies analysed was the online waste system that all waste generators need to make use of to track waste, along with the repercussions that could be implemented if standards are not met. Discrepancies in the policies compared to the data collected were the actual audit. While the policies spoke of such audits, the data contained inconsistencies as some have had visits from the government, while others say they have never been visited as well as some saying there is notification of these audits while others say the audit can happen without warning. This potentially indicates a weakness in the relationship between legislation and the physical implementation thereof.

4.5.4 Waste disposal longevity for future methods and sustainability

When looking at waste disposal longevity for the future it is suggested by the data that South Africa is still heavily reliant on landfills and hoping to keep making use of them, as land does not come at shortage. However, there is not as much land available within the city itself and landfills would need to be opened on the city outskirts which would make it more expensive for all waste generators due to rising transport costs and general inflation. This is where the industry could potentially be forced toward a more sustainable approach in dealing with construction and demolition waste soon.

The data showed that on-site crushers to make recycled aggregate do exist but are very rarely used or even known as an option. Making this recycled aggregate helps that the waste never leaves the actual site itself and is used right back into the project as a fill where necessary. Those working in the recycled aggregate industry would then have more opportunity to make and sell the aggregate which essentially leads to slightly greener construction. If the landfills are on the outskirts of the city, it could result in companies making more use of recycling plants or even incineration kilns if the transport cost of getting all waste to the landfill outweighs the cost of transporting waste to- and making use of – more sustainable disposal methods. When it comes to more innovative ways of dealing with construction and demolition waste sustainably, there are various options that participants indicated, however, it would seem as if those options are not in the near future. One of these examples provided in the data is using waste to generate electricity however, this would require vast machinery and millions of rands to try and implement.

The data collected did not provide too much information on sustainability other than the fact that most participants indicated that the country does not have sustainability in mind yet, and some changes would need to be implemented for sustainability to become a reality. However, it was suggested that small steps are being taken even if they are not seen as strides just yet. To answer the question, of which disposal method is better suited for longevity and sustainability, the answer would appear to be recycling based on participant answers. However, the data also suggested other factors need to be considered in this regard including, air pollution from the transport as well as the technology used to drive the recycling plant. This topic could therefore be a separate research study.

4.5.5. Limitations of the study

Limitations for this study were largely based on participant availability and willingness to participate in the study. Many businesses said they do not do interviews while some even feared the study is a front for some or other spy activity into the companies' methods. People were reluctant to give up time to participate or simply never replied to any communications. Due to the nature of the study being construction and demolition sites, it was not possible to simply show up to a construction site to ask for interviews due to safety regulations and often the contractor or foreman not being present all hours of the day. Many potential participants also did not want to be part of the study as they felt they did not know enough about the topic to provide any valuable information. Although this study was from a niche market, to begin with, and knowing there would not be large amounts of participants available, the sample size was smaller than anticipated and just a few more interviews could have been beneficial and allowed for somewhat more generalisation. If more time was available, the study site could have been increased to try and add more participants. Some participants invited the researcher to come to have a look at the site itself, however, due to financial and transport constrictions this was not possible. Finally, it was hard to correlate or find discrepancies in the data collected with existing literature due to the limitations of existing data on the subject matter based in Gauteng, South Africa.

4.5.6 Recommendations for future studies

This study contributes directly to the literature on construction and demolition waste management for South Africa, however, due to the limited availability of literature and

this research being a single dissertation, further study would be required to make up a more encompassing availability of data. The study site for this research was only a small section of Johannesburg, Gauteng, therefore future researchers could use this data and add on to it by adding more and more study sites and perhaps using larger areas as well as other provinces to try and make data for South Africa as a whole. This research therefore cannot be used alone for external non-academic purposes but does add to the foundation of what could be used in the future by the construction and demolition industry or even policymakers of waste management.

Future researchers could involve government waste entities such as Pikitup or other waste management in their data and get their perspective on the subject and not just the private sector as was done in this study. Future researchers could also add some quantitative data such as amounts of waste and where those waste streams end up seeing more statistical figures as to what ends up in landfills and what goes into the circular economy. Finally, a different and more specific approach to sustainability could be implemented in a future study as this study could not reach a conclusion on sustainability due to it being looked at too broadly.

CHAPTER 5

CONCLUSION

This study set out to assess the disposal methods of construction and demolition waste in South Africa in the south-eastern region of Johannesburg. It looked at disposal methods and aimed to answer the following questions: a) *What are the current disposal methods of construction and demolition waste used in South Africa and how does it compare to other countries? b) Which of these methods is a more sustainable option to use? c) What part do legislation and policy play in the disposal of construction and demolition waste in South Africa?*

The main findings determined landfill and recycling to be the main disposal methods of construction and demolition waste in South Africa, which is in line with many other countries and only a few other countries named in the study made use of more innovative ways to dispose of their construction and demolition waste. The research could not substantiate a supported argument for the second research question that focused on the more sustainable option and could only make a general inference to the issue that sustainability is not currently a priority for most and that the topic is not as much focused on in the industry yet. The final question on policy and legislation showed a complex relationship between written documents and the physical implementation thereof. Various gaps were identified in the data collected and policy analysis. The main focus could be seen as the legislation and implementation gap that needs to be bridged, along with legislation that could be more specific on categorising waste through differentiating between larger and smaller waste contributors and creating policies accordingly.

Due to the research being of qualitative nature, the findings could contribute to a new study and be interpreted differently in conjunction with new and more research findings. The implications of this research are as developing countries strive towards development, construction and demolition will continuously contribute to waste generation. Therefore, the way in which construction and demolition waste are dealt with will need to be altered and reflected upon moving forward and trying to move towards a more circular economy.

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