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Creating a Conducive Environment for Improved Solid Waste Management in South Africa: Case of City of Cape Town Metropolitan Municipality

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Abstract

What are the key factors required for improved solid waste management? The novelty of the study lies in identifying the key factors needed for effective solid waste management in the City of Cape Town metropolitan municipality. The research was qualitative in nature. In this study, the purposive sampling technique was used to obtain a sample size of 12 participants. Data in this study were collected through online interviews. A semi-structured interview guide was used as a data collection tool. Thematic data analysis was used to analyse the data. Research findings indicated that improving solid waste management in Cape Town requires a strong policy framework, modern infrastructure, and advanced technology. It was established that there is a need for financial incentives, which are crucial for funding and innovation, while good governance and institutional capacity are also required to ensure effective implementation. Key policy recommendations that were suggested were: strengthening regulatory and transparency frameworks, investing in smart waste management infrastructure and technology, introducing financial incentives and sustainable funding models, and enhancing governance and institutional capacity.

Keywords

City of Cape Town, Solid Waste Management, Sustainable Development Goals

1. Introduction

The City of Cape Town is a large metropolitan area in South Africa with a population of over 4.7 million people [1]. Solid waste management (SWM) is defined

as a process of gathering, processing, and disposing of solid waste that is no longer useful, with a strong focus on resource conservation and lowering the negative effects on the environment [2] [3]. The City of Cape Town is confronted with a challenge of SWM. This is supported by the City of Cape Town, which stated that with its current landfill airspace expected to run out around 2036, the City of Cape Town is facing an impending waste management crisis. This can lead to the exposure of people to health hazards if there are no alternative measures introduced to deal with solid waste [4]. If solid waste is not disposed of efficiently, it may also affect the environment, and this can also adversely impact the chances of South Africa to attain the Sustainable Development Goal (SDG) 13 of climate change [5]. From a financial perspective, the City of Cape Town uses R350 million to clear illegally dumped waste, and this shows that the metropolitan municipality is facing a challenge of SWM [6]. This drains the financial resources of the City of Cape Town metropolitan municipality. In addition, the City of Cape Town metropolitan municipality is confronted with a number of challenges as far as SWM is concerned. Some of these challenges are: increased population which leads to increased solid waste generation, illegal dumping, poor infrastructure, and limited landfill capacity among others [6]-[8]. These challenges show that there is a lack of a conducive environment needed for effective SWM.

To that end, the research question to be answered in this study is stated below:

How can a conducive environment be created for improved solid waste management in South Africa?

A study researched informal waste recycling systems in Cape Town. Research findings indicated that the integration of waste pickers helps in improving SWM [9]. The study is silent on how a conducive environment can be created to ensure effective SWM. A mixed research method was conducted to investigate solid waste management in cities and towns in South Africa. According to the study, waste management cannot be handled solely by the local government [10]. Shared accountability for maintaining clean environments is necessary, and an active process where participants hold one another accountable should be welcomed [10]. The study does not outline the key factors needed to create a conducive environment for the local government and other stakeholders to work collaboratively in effective solid waste management. This shows that there is a research gap. Another study used interviews in qualitative research to explore rubbish build-up in Khayelitsha, Cape Town [11]. Research findings indicated that dumping of rubbish was the main method of refuse disposal used by the residents in Khayelitsha. This research does not address how or what can be done to ensure that there is an enabling environment for SWM. Given the above discussion and to the best knowledge of the author, there is no research that clearly articulates how a conducive environment can be created for effective SWM in the City of Cape Town metropolitan municipality.

The novelty of the study lies in using interviews to obtain more in-depth information from the official who works in the solid waste division for the municipality

in question. The use of interviews has the potential to provide insights into how a conducive environment can be created for effective SWM. The study is crucial for informing policy in SWM. Effective SWM is important for promoting good health practices for citizens, thereby helping to improve the attainment of SDG 4 on good health. This can also have a multiplier effect on the attainment of other SDGs, such as Goal 1 on poverty reduction. This is justified from the premise that poverty is a multidimensional aspect, and it encompasses access to health, education, and other aspects. As such, effective solid waste management is very essential as it helps in the attainment of other SDGs in a non-deterministic way. SWM can be beneficial to an economy in diverse ways. This can be in the form of job creation. For example, in Europe in 2015, over 900,000 were employed in the waste industry [12]. The City of Cape Town can also benefit from effective solid waste management, provided there is a creative, conducive environment provided. Apart from this economic benefit, SWM can help in environmental protection. With an average of roughly 67%, Germany has one of the highest municipal solid waste recycling rates in the world [13]. All these benefits can also accrue to the City of Cape Town metropolitan municipality, provided a creative, conducive environment for effective SWM is established.

The rest of the paper is structured as follows: Section 2 presents the methodology. Results and discussion fall under Section 3. Section 4 provides the conclusion of the study.

2. Methodology

The study was based on the use of qualitative research techniques. The main focus of the study was the City of Cape Town metropolitan municipality. Ethical clearance to collect the data was obtained from the respective municipality. The target population was the top, middle, and lower-level management in the City of Cape Town metropolitan municipality. The study focused on employees who had knowledge of solid waste management. To that end, purposive sampling was used to select the participants needed for data collection. The advantage of using purposive sampling is that it allows high-quality data collection since the researcher focuses on only the participants who can provide the much-needed information on the subject matter [14]. This is also beneficial in meeting the research objectives of the study.

In qualitative studies, there are no uniform or standard numerical criteria that can be used to determine the sample size [15]. Clarke & Braune, in their study, have proposed that a minimum sample size of 12 should be employed in qualitative research to attain data saturation. In this study, a sample size of 12 participants was used [16]. This sample was obtained through purposive sampling. The most important condition to be met in data collection, especially when using interviews, is reaching data saturation [17]. After interviewing the 12th participant, no new information was obtained, and the researcher concluded the interviews.

Data in this study was collected through online interviews. All the interviews

were audio recorded. A semi-structured interview guide was used as a data collection tool. Interviews were used because they enabled the researcher to ask probing questions, which enabled more information to be collected on the subject matter [18]-[19]. The data collected through interviews was analysed through the use of thematic data analysis. This technique was used because it is flexible and allows for deeper interpretation of the themes obtained from the study, and this is useful for meeting the objectives of the study [20].

3. Results and Discussion

This section presents the results and discussion. The response rate was 100%. To fulfil the ethical condition of privacy and confidentiality, all the participants were given pseudonyms. The pseudonyms that were given for participants 1 - 12 were P1, P2, P3, P4, P6, P7, P8, P9, P10, P11, and P12. The key themes that were drawn from the data are presented below:

Table 1. Key themes and codes.

Theme	Sub-Theme
Creating an enabling environment for solid waste management y	Policy and regulatory framework, infrastructure and technology, economic and financial incentives, governance and institutional capacity

Table 1 above shows that the key theme was Creating an enabling environment for solid waste management. The sub-themes were policy and regulatory framework, infrastructure and technology, economic and financial incentives, and governance and institutional capacity. Participants' responses will be used to justify discussions. These responses may not be cited in chronological order. The main theme will be discussed below:

Theme 1: Creating an enabling environment for solid waste management

This is the main theme of the study. Based on the views of the respondents, it shows that there are a number of factors that must be taken into account to ensure that there is effective SWM in the Cape Town metropolitan municipality.

Implication of the responses of the participants

The following factors to be discussed are the policy and regulatory framework, infrastructure and technology, economic and financial incentives, and governance and institutional capacity.

Policy and Regulatory Framework

This is the first factor that was mentioned as being very critical in creating a conducive environment for solid waste management in the Cape Town metropolitan municipality. Several responses from the participants highlighted the significance of regulatory and policy measures in improving solid waste management in Cape Town. Below is an extract from the views of participants P2 and P5.

> "In my view, I suggest availing financial incentives for use in solid waste operations is very important and requires good regulatory frameworks" P2—

(October 2024).

"We need sophisticated technology to improve solid waste management. Smart bins and IoT sensors: smart bins equipped with sensors to monitor bin volumes, optimize collection routes, and reduce. IoT sensors on bins to track and report data on waste generation patterns in real time. Waste to Energy. Also, there is a need for a supportive policy framework to address key challenges such as corruption in the tender process" P5—(October 2024).

P2 suggests that "good regulatory frameworks" are very important, while P5 explicitly mentions the need for a supportive policy framework to address corruption in the tender process. These same sentiments were also supported by P11.

"There are many things that can be looked at, for example: infrastructure readiness, data management and analytics, skilled workforce and training, public awareness and engagement, sustainability focus, regulatory and policy support, financial investment and partnerships," P11—(October 2024).

The above response shows that P11 also acknowledges "regulatory and policy support" as a crucial component. All in all, the above explanation clearly shows that the Cape Town metropolitan municipality needs to ensure that there are good regulatory frameworks in place to enable efficient solid waste management.

A well-structured policy environment helps to ensure that solid waste management systems are efficient, transparent, and aligned with sustainable development goals such as goal 13 of climate action. It is also very important to note that, for instance, P5 brought up the issue of corruption in tenders, which is a stumbling block in waste management.

If procurement processes are not transparent, investments in infrastructure and technology may not yield desired outcomes. This is because poor quality infrastructure may be developed, and this adversely affects SWM. Apart from that, corruption may imply diversion or embezzlement of funds, leading to bottlenecks as far as solid waste management processes are concerned. From a literature perspective, other scholars such as Mashiane & Odeku posited that South Africa has established a legal framework for solid waste management, but it requires enhancements to improve enforcement and effectiveness [21]. Korstanje *et al.* also share similar views with Mashiane & Odeku in their research that looked at barriers to solid waste management in KwaZulu-Natal, South Africa [21] [22]. Korstanje *et al.* went on to mention that policies on solid waste management should be tailored to meet the needs of local government [22]. Muheirwe *et al.* support the views of Korstanje *et al.* and Mashiane & Odeku on the need for good policies and regulations to ensure efficient solid waste management. To that end, this same approach can also be used for the City of Cape Town metropolitan municipality [21]-[23].

Infrastructure and Technology

Infrastructure and technology improvements were widely emphasized as essential for enabling effective SWM in the Cape Town metropolitan municipality by a

number of participants. Below is an extract:

> "I think investment in modern infrastructure is very key for the Cape Town metropolitan municipality to improve waste management. Another thing is good financial investment." P1—(October 2024).
> "There are a number of factors to take into account: for example, new technological equipment, training workers to have the knowledge on the use of Industry 4.0 technology, and improvement in solid waste management." P7—(November 2024).
> "Ageing infrastructure must be replaced; this helps to reduce breakdowns, and the metropolitan municipality will be able to run smoothly." P9—(November 2024).

The responses above show that P1 suggested investment in modern infrastructure as a key solution to improved SWM, while P9 stressed the importance of replacing aging infrastructure to prevent breakdowns. To add more, other participants such as P5 and P7 proposed the use of sophisticated technology, such as smart bins, IoT sensors, and Industry 4.0 technologies, as transformative solutions required by the City of Cape Town metropolitan municipality.

These responses align with global trends in smart waste management, where real-time data collection helps optimize waste collection and reduce operational costs. IoT sensors, as suggested by P5, can provide real-time waste generation patterns, leading to more efficient resource allocation. However, while the adoption of these technologies is beneficial for effective SWM, these technologies may require substantial financial investment.

Finally, P7 acknowledged the importance of training workers in the usage of Industry 4.0 technologies. However, without a structured workforce development plan and resources for training, technology adoption might face resistance or inefficiencies. Literature, especially by various authors, concurs with the above primary research findings. According to research findings by these authors, with the correct investments in technologies and institutional changes, garbage has the potential to become a resource that contributes to cities' socioeconomic development [3] [24]-[26]. It can therefore be concluded that investment in modern infrastructure and harnessing modern technologies enveloped in Industry 4.0 is very critical for improving solid waste management.

Economic and Financial Incentives

In order to create a conducive environment for improved solid waste management, economic and financial incentives must be taken into account. A number of responses recognize the financial aspect of improving solid waste management in the City of Cape Town metropolitan municipality. P1 argued that good financial investment is necessary, while P2 proposed financial incentives for solid waste operations. P11 also outlined financial investment and partnerships as a key area that need to be looked at by the City of Cape Town metropolitan municipality.

P2's suggestion of financial incentives is particularly relevant, as subsidies and tax breaks for waste recycling and disposal innovations have been successful in

other cities. For example:

The incentives can be provided to private waste management companies, informal waste pickers, or the general public to encourage recycling. It is also crucial to point out that if the City of Cape Town metropolitan municipality considers the option of financial incentives, they must be strategically and measurably designed; otherwise, the risk of misallocation or ineffectiveness can occur. This is also supported by Alhanaqtah, who posited that effective financing structures and initiatives are crucial for SWM, particularly in developing nations where municipal financing is often limited [27]. Nahman *et al.* agree with Alhanaqtah on the need for effective financing options [27] [28]. Nahman *et al.* went on to posit that taxes can be used to generate the much-needed revenue and, in particular, the tax ought to be imposed at a rate commensurate with the external cost per tonne of waste that is landfilled [27].

Governance and Institutional Capacity

Based on the views of participants, it was established that governance and institutional capacity are crucial for effective solid waste management in the City of Cape Town Metropolitan Municipality. The responses of the participants are listed below:

> "Well, I think we need more government support and improved institutional capacity to ensure solid waste management is improved," P8—(November 2024).
>
> "A robust data infrastructure needs to be in place to collect, analyse, and act on insights in real time. Also, we need more technical expertise, to address some of the inefficiencies caused by bureaucracy, and to improve departmental linkages." P10—(September 2024).

Based on the above responses, P8 stated that more government support and improved institutional capacity are needed, while P10 and P11 emphasize the need for a skilled workforce and training to address the lack of technical expertise, bureaucratic inefficiencies, and poor interdepartmental coordination. Moreover, P10's call for a robust data infrastructure is particularly relevant in this regard. Data-driven governance can enhance decision-making by tracking waste generation, monitoring landfill capacity, and optimizing waste collection schedules. These primary research findings from this study are also supported by Munawir *et al.*, who indicated that in order to ensure the sustainability of waste management, it is necessary to have strong institutional synergy, and this can be achieved by conducting activities that are based on the environmental cleanliness improvement program's objectives [14]. In agreement with Munawir *et al.*, Omotayo stated that in order to improve SWM, political will must be ensured and government institutions' capacity must be increased through policy-making, regulation, and technical and managerial capabilities of local authorities [14]-[29].

The findings from this study highlight several key factors that are essential for improving solid waste management in the City of Cape Town Metropolitan Mu-

nicipality. The responses from participants underscored the significance of a well-structured policy and regulatory framework, infrastructure and technology improvements, economic and financial incentives, and governance and institutional capacity. Each of these factors plays a critical role in creating a sustainable and efficient waste management system that aligns with global best practices and the broader goals of sustainable urban development. Overall, it can be concluded that achieving improved solid waste management is hinged on a mix of factors, and this requires the City of Cape Town Metropolitan Municipality to take a holistic approach in ensuring that the aforementioned issues are taken into consideration.

Policy Recommendations

This section presents the key policy recommendations. It is very crucial for the City of Cape Town metropolitan municipality to take into consideration the key factors needed for improving solid waste management. This helps in creating a cleaner environment, reducing health hazards, as well as any adverse effects that can impact the environment. From a broader context, this will help to increase the chances of attaining SDG 4 of good health, 13 of climate action, just to mention a few. To that end, the following policy recommendations are suggested: strengthen regulatory and transparency frameworks, invest in smart waste management infrastructure and technology, introduce financial incentives and sustainable funding models, and enhance governance and institutional capacity. These are discussed in detail below:

Strengthening Regulatory and Transparency Frameworks

The City of Cape Town metropolitan municipality needs to strengthen regulatory and transparency frameworks. This can be achieved by enforcing stricter procurement regulations to prevent corruption in waste management tenders. Apart from that, the municipality can also achieve this by introducing modern digital tracking systems for monitoring waste collection, disposal, and financial transactions. This transparency framework can also help to ensure that the municipality remains financially healthy.

Investing in smart waste management infrastructure and technology

The City of Cape Town metropolitan municipality must invest in smart waste management infrastructure and technology. This can be achieved by integrating IoT-enabled smart bins, AI-driven waste collection optimization, and modern recycling facilities to improve efficiency and sustainability. This will also help ensure proper training for waste management personnel in using these technologies. It is therefore highly recommended that the City of Cape Town metropolitan municipality invest in modern technology.

Introducing financial incentives and sustainable funding models

The third policy recommendation that is suggested is to introduce financial incentives. Introducing financial incentives and sustainable funding models by providing tax breaks, subsidies, or grants is very important to ensure that solid waste management is improved. This can be channeled to private waste management companies, informal waste pickers, and recycling programmes.

Enhancing governance and institutional capacity

Finally, the City of Cape Town metropolitan municipality can enhance governance and institutional capacity. This can be achieved through fostering interdepartmental coordination, establishing a dedicated SWM task force to streamline operations, and implementing data-driven decision-making through real-time waste monitoring and predictive analytics. These policy measures, if effectively implemented, will help create a robust, transparent, and sustainable SWM system in Cape Town, aligning with global best practices and environmental sustainability goals. In the end, these policy recommendations may improve solid waste management as well as assist in the attainment of diverse Sustainable Development Goals.

4. Conclusion

This qualitative study sought to identify the key factors needed for effective solid waste management in the City of Cape Town metropolitan municipality. The research findings indicated that to create a conducive environment for improved solid waste management, the City of Cape Town metropolitan municipality must ensure that there is a robust policy and regulatory framework. In addition, the metropolitan municipality must also invest in modern infrastructure and technology for use in solid waste management. It was also established that economic and financial incentives must be made available to fund solid waste management. Finally, research findings indicated that the City of Cape Town metropolitan municipality must put in place good governance and develop institutional capacity needed for effective solid waste management. The research findings from this study suggest that for the City of Cape Town to improve its solid waste management, a multi-faceted approach is necessary.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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