

Evaluating Enforcement Strategies for Curbing Illegal Waste Dumping: A Case Study of King Sabata Dalindyebo Local Municipality, South Africa

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ABSTRACT

Illegal dumping of waste can be classified as a considerable risk to the sustainability of the environment and the well-being of the people in the urban local area, including the King Sabata Dalindyebo Municipality (KSDM) in South Africa. In spite of the intervention of regulatory regimes to alleviate this, cases of illegal dumping still occur, wherein low-income neighborhoods are over-represented. The current mixed-methods study evaluates the success of the use of municipal interventions to reduce the incidence of illegal dumping within the KSDM communities. A multi-dimensional approach, which consisted of a set of semi-structured interviews with the municipality officials and community representatives, as well as closed-ended questionnaires used to examine 80 selected residential citizens in four localities, was applied. The results of the SPSS analysis based on quantitative data provided a descriptive statistic of community perceptions, and the thematic analysis of qualitative responses allowed producing the categories of their descriptive characteristics. The ArcGIS mapping and proximity analysis were deployed to rate the spatial location of the dumping sites; bins known as skipper and notice boards. The results obtained show that enforcement methods are significantly effective in areas with high incomes, Southridge and Southernwood, where compliance with waste-management rules is consistent and, in these regions, the municipal waste services are not disrupted. In comparison, the lower-income regions, especially Mandela Park and Ngangelizwe have limited resources which inhibit compliance and further frustrate dumping. The research concludes that the current regulatory responses are likely to focus on symptomatic, rather than structural causes of illegal dumping, and therefore make long-term effectiveness a challenge. In this respect, a more combined resource-sensitive model is advised to enhance enforcement across the socio-economic lines.



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1. Introduction

Global waste generation has been on the increase because of economic expansion, population growth and rapid urbanization, with projections estimating a rise from 2 billion tons to 3.4 billion tons by 2050 (Kaza et al., 2018). This growth is driven by the emergence

of a global middle class characterized by higher consumption rates, especially in developing countries (Da Silva et al., 2019; Kaza et al., 2018). However, this growth is not complemented by effective waste management systems like collection, transport, recycling, and proper disposal of waste, leading to a rise in illegal dumping (Ahmed et al., 2024; Ministry of Ecology and Environment, 2018; Ragmoun & Alwehabie, 2020; Seror & Portnov, 2020; Yang et al., 2019).

Communities in South Africa are not excluded from the issue of illegal dumping, making it extremely difficult for municipalities to provide efficient waste management services. These problems are not recent; African nations, like all developing countries, have struggled with solid waste management and illegal dumping since the eighteenth century (Khuluse & Leonard, 2024). As one of the most urbanized countries in Africa, South Africa faces growing pressure to develop effective waste management strategies that are aligned with sustainable development goals. The country generates approximately 122 million tons of solid waste annually, with 12.7 million tons from households (Africa, 2018). Around 31% of households lack access to formal waste collection services, thereby exacerbating waste management problems, especially in under-resourced areas (Rodseth et al., 2020).

One of the interventions involves putting in place effective collection mechanisms to encourage the reduction of solid waste at the source. The process of sustainable urban development requires the active coordination of involvement of NGOs, corporate sector and municipalities (Grobler et al., 2022). However, the performance of such efforts in varying urban settings is unproductively undermined by implementation differences and socio-economic inequality. The Municipality of King Sabata Dalindyebo (KSDM) located in the Eastern Cape is a good example. Despite various enforcement measures, illegal dumping of wastes has been on the increase, creating water pollution in the Mthatha River, and adding more strain to local authority funds. Such realities highlight inconsistencies in the form of an incongruency between desired policy aims and visible results.

This research also therefore measures the effectiveness of the enforcement measures implemented by the KSDM in controlling the illegal dumping of waste. The intervention focuses on determining the specific enforcement mechanisms used by the municipality and determines awareness and understanding of waste-management by-laws in the community. Additionally, it questions the degree at which the current enforcement mechanisms have lowered accidental dumping. The results should help in guiding policy improvement, allocation of resources, and people involved in KSDM, thus bringing cleaner and safer cities and setting a possible standard that municipalities will be facing similar challenges over time.

2. Study Context

The current study was conducted in the King Sabata Dalindyebo (KSD) Local Municipality, which is one of 5 local municipalities forming the OR Tambo District of the Eastern Cape Province of South Africa. The municipality has a total area of 3,027 km and has rural and urban aspects of the municipality with the city of Mthatha (previously Umtata) constituting the administrative, and commercial core, as shown in Figure 1.

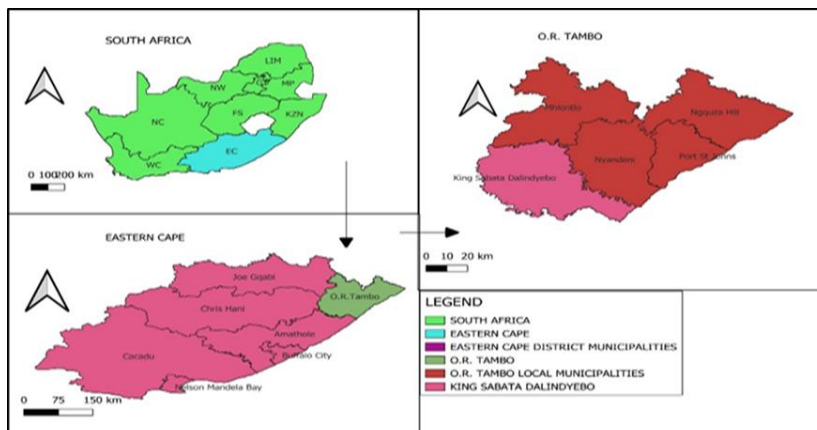


Figure 1: Map of King Sabata Dalindyebo (KSD) Municipality

Source: Author creation, Ntlangula, 2024

Mthatha is situated along the Mthatha River, which has a strong history in the region's ecology and settlement patterns. However, the river is increasingly subject to pollution, much of it resulting from illegal waste dumping. As such, this study aims to address the impact of illegal dumping and offer strategies which may be implemented in KDSM. The municipality's geography is characterized by hills, wetlands, forested patches, and agricultural land. Thus, if waste is left uncontrolled there is a risk of pollution and environmental degradation.

The municipality has a diverse population of approximately 476,556 people, primarily comprising Xhosa-speaking communities (Africa, 2022). This reflects a mix of socio-economic conditions, with significant contrasts between well-resourced urban communities and under-serviced informal or peri-urban areas. The four study sites, namely Mandela Park, Ngangelizwe, Southridge, and Southernwood, were selected to show this socio-economic diversity. There are various pieces of legislation that govern waste management in KDSM comprising Municipal Structures Act (Act 117 of 1998), the Municipal Systems Act (Act 32 of 2000), and the Spatial Planning, Land Use Management Act (Act 16 of 2013) and its local municipal by-laws.

3. Literature Review

In South Africa, waste management has grown to be a significant environmental concern. Section 156(1) (a) read with Schedule 5 of the South African Constitution (RSA, 1996) gives municipalities authority over solid waste disposal, refuse collection, and refuse dumps. Even though most towns handle solid waste management themselves, some district and metropolitan municipalities contract out the work, but this practice appears to be declining (Polasi, 2020). Globally, there is growing issue over the volume and complexity of municipal solid trash that is linked to the contemporary economy and the fast rate of urbanization. The ineffective implementation and enforcement of solid waste management (SWM) regulations and laws has contributed to the serious issues governments face in managing MSW, particularly in developing nations (Amugsi et al., 2022).

Despite the importance of regulation, many developing countries have experienced different waste management policy outcomes. For example, despite having a proactive national solid waste policy, Brazil's solid waste management situation has not improved. Even though India has laws covering all types of waste, there is still a lot of uncollected waste. In the same vein, the regulation of solid waste management has not produced the desired outcomes in Sub-Saharan Africa. Furthermore, some nations with presumably "adequate regulation" are said to have worse solid waste management outcomes than those with limited legislation (Muheirwe et al., 2022). SWM is a significant environmental problem that many South African communities have not yet managed to resolve. Despite government initiatives to optimize trash collection services in urban and semi-urban regions, the absence of a thorough management and planning strategy has hindered SWM performance in South Africa. Maladministration, inadequate institutional infrastructure, and fragmented and misinterpreted laws have all reduced SWM efficacy in South Africa. The foundation of waste management in South Africa is comprised of various laws and regulations. The waste management mandate authorizes the grading of waste, avoidance, recycling, reuse, minimization, recovery and disposal, in ascending order of preference (Kubanza, 2025).

3.1. Enforcement and Waste Management Strategies: Global Insights

Waste management is now considered an essential part of environmental management and sustainable development. The circular economy concept emphasizes the need to extend product lifecycles, improve recycling, and reduce waste in order to preserve the value of resources within the economy for as long as feasible. However, the best waste management approach is to stop garbage from being generated in the first place. With this strategy, waste and pollution are reduced from the start in the design of both products and processes. Strategies include developing production procedures that minimize waste generation and designing products with durability, reparability, and recyclability (Yuzvovich et al., 2024).

Waste management and environmental control have a long history in the UK. Its waste regulations place a strong emphasis on encouraging sustainable behaviors, recycling, and minimizing landfill garbage, making the UK a pioneer in sustainable waste management. Laws like the Landfill Tax and Extended Producer Responsibility (EPR) rules have significantly reduced landfill waste. The United States exhibits heterogeneity in waste management practices, given that, in most cases, waste regulations are enforced on a sub-national basis. Federal legislation, including the Resource Conservation and Recovery Act (RCRA) and a variety of Extended Producer Responsibility (EPR) measures, provide minimum standards on waste minimization and disposal premises, but there are some state and local governments that mediate their operation and the overall impact. Such a decentralized scheme of administration integrates both local variation and non-uniformity, which yields mixed results in terms of waste decrease and sustainability.

3.2. The South African Context: Causes and Responses

On the one hand, illegal dumping is commonly fueled by an array of interconnected determinants, which may include a high urbanization rate, unfair service delivery, and socio-economic inequality (Rodseth et al., 2020). A considerable proportion of households, estimated to be over 31 % at present, do not have dependable waste-collection services, and as a result, such communities engage in informal waste-disposal methods. South Africa generates more than 122 million tons of solid waste each year, of which about 10 % (about 12.7 million tons) are derived domestically. The rise in solid waste output is explained by population increase, urbanization, economic expansion, and human behavior in general, all of which are in line with the emerging BRICS economies. According to Gutberlet and Bramryd (2025), governments around the world struggle with issues related to open burning, littering, poor waste management, and the inability of wasted items to be recycled. This is a situation that will likely be worse in South Africa, a country with one of the highest rates of urbanization in the world, which will make waste management issues worse (Ngalo & Thondhlana, 2023).

In 2017, South Africa produced 42 million tons of general waste. Based on reports, just 59% of that amount was properly collected. According to the South African National Garbage Information Baseline, regular garbage collection would not be feasible even if towns tried to offer all homes fair waste collection services. This is due to several issues, including urbanization and migration, distance, excessive trash production, the emergence of new waste streams, and the expenses associated with waste management (Niyobuhungiro & Schenck, 2021). Moreover, poor financial management is a serious problem in South African municipalities, as indicated by negative audit findings. This problem has multiple causes, such as corruption, financial mismanagement, a lack of transparency, and insufficient oversight. These elements influence the provision of necessary services to citizens as well as the towns' financial viability (Mashabela & Thusi, 2024). Thus, the above-mentioned issues make it difficult to deal with waste management in KDSM.

3.3. Enforcement Strategies in South Africa: lessons from Kenya and England

Because Kenya is a developing nation with solid waste management issues comparable to those in South Africa, whereas England is a developed nation with sophisticated garbage management systems, South Africa can learn from Kenya and England to enhance and strengthen its waste management policies and procedures (Mashiane & Odeku, 2024). The principles of appropriate solid waste management methods, such as reducing, recycling, reusing, composting, and segregating garbage at the source, should be prioritized in South Africa. This helps reduce trash and motivates citizens to be environmentally conscious and act. Offering waste management services, such as plenty of bags for collecting household waste, additional trash cans for public use, timely collection, and an emphasis on waste handling education and awareness, can help achieve this goal (Kubanza, 2025). However, despite the potential efficacy of these interventions, surveillance proves far less effective in informal settlements, where logistical barriers and off-grid dumping complicate monitoring efforts. Enforcement practices are highly variable, a fact that can be attributed to the limited municipal resources in most jurisdictions. Despite theoretical involvement of probes into the deterrent that fines have to the informal waste

disposal, the scholarly discussion has often questioned their fairness, which is argued to affect the low-income residents disproportionately (UNEP, 2023).

3.4. Policy and Regulatory Framework

In South Africa waste governance is embodied in the National Environmental Management: Waste Act, 2008 (Act 59 of 2008), which sets forth the statutory framework of sustainable waste governance and the prevention of environmental degradation. More specifically, Section 9 of the Act requires all the municipalities to prepare an Integrated Waste Management Plan (IWMP) which is a strategic planning document that should capture local realities and direct long-term planning and practical implementation. The legislation also empowers municipalities to implement custom-made bylaws, which are aimed at mitigating their waste-management problems in particular areas (Godfrey & Oelofse, 2017).

One such example is the project of a Smart Surveillance System to control illegal garbage dumping, which uses computer-vision solutions and machine-learning algorithms to observe cases of waste dumping in publicly shared areas, notify legal authorities about such events in real-time, and minimize environmental pollution related to illegal waste disposal. Common implementations of the system include penalties toward the non-compliance of the system, community involvement in reporting and preventing dumping activities, and focusing on constant surveillance of already established dumping hotspots.

According to Article 24 of Bill of Rights of South Africa, the citizens have a right to the environment that will not endanger their health as well as well-being, thus, becoming the basis of the environmental regulation and policymaking. The municipalities are required under the National Environmental Waste Management act of 2008 No 59 to incorporate IWMPs into their integrated development plan. The majority of Integrated Development Plans (2017-2022) developed by municipalities have focused on reduction processes more than prevention measures. That said, the so-called solutions still do not get rid of the problem. With no apparent efforts to enforce the problem effectively, as well as alternatives, the level of compliance to the Waste Act is weak, whereas illegal dumping site continues to be a normalized activity in most parts of South Africa. These disparities underscore a critical gap between policy intent and on-the-ground realities, particularly in marginalised communities where environmental risks are compounded by socio-economic vulnerabilities.

The success enforcement strategies that can significantly reduce illegal dumping hinges on adequate infrastructure, sustained public engagement, and responsive governance in the South African context. Especially within municipalities like KSD, enforcement strategies often fall short due to limited resources, socio-economic disparities, and inconsistent service delivery. The existing evidence of policy instrument assessments is limited, especially in the municipality context of the mixed-type landscape like the King Sabata Dalindyebo Municipality. The current research examines the effectiveness of the enforcement mechanisms that work in the municipality, their perceived effect, and the perception of beneficiary communities, producing evidence to improve local and national policymaking.

4. Research Methodology

The research utilized a mixed methods design wherein the effectiveness of the enforcement systems aimed at illegal dumping in King Sabata Dalindyebo (KSD) Municipality was measured. The study involved both quantitative and qualitative processes to reflect both statistical trends and contexts. Quantitative data was compiled by conducting structured questionnaires to 80 randomly selected residents of Mandela Park, Ngangelizwe, Southridge and Southernwood, which were selected intentionally to capture a diversity of social-economic surroundings. In total, 20 respondents were provided in each community, and they reported on how many times illegal dumping happened, how well they knew municipal waste regulations, and how they evaluated the efficiency of the enforcers.

In addition to the questionnaire survey, semi-structured interviews were also conducted with the municipal officials, law-enforcement personnel, as well as the community leadership to gain a deeper insight into the nature of policy application, the gross accountability of the institutes, and community involvement in maintenance of waste. Secondary data was also used by using municipal reports, government gazette, and academic literature to place the findings in context.

The SPSS was used to analyze quantitative results, and descriptive statistics demonstrated the pattern of responses to the community. In the spatial analysis, ArcGIS was used to create maps to show distribution of illegal dumping sites, notice-board placements, and skip-bin locations; a second map displayed 500-metre buffer zones around each skip bin to show the spatial extent of formal waste-disposal facilities. Such visualizations were essential in plotting the root cause of spatial dynamics on illegal-dumping behavior. Thematic analysis of qualitative data revealed the main shared concerns, which included ineffective municipal capacity, the narrow public awareness and varying attitudes towards enforcement strategies across the communities. The study gave an extensive evaluation of the current enforcement policies used, and how they matched the immediate reality, through statistical, spatial, and thematic integration of data.

It is imperative to protect a study participant and ensure high ethical requirements are exercised in designing the methodology of a study and during decision-making as well. Ethics refers to the science of right and wrong which entails the sets of rules that determine moral judgment, beliefs and actions regarding a wide range of activities. On this basis, the concerns of ethics were in the focus in the current study. The informed consent of all participants was obtained and the research protocols ensured that everything remained confidential, such as data anonymization and even safe storage. The participants were notified that they have the right to withdraw at any time, thus, meeting the conditions of ethical practice. This research methodology allowed evaluating not only directly measurable results but also background factors of this action of the municipality to reduce the problem of illegal dumping, thus setting a strong basis on the results presented in the following chapter.

5. Presentation and Discussion of Results

Demographics characteristics of the respondents played a critical role in explaining disposal behaviors and attitudes to municipal enforcement efforts. The sample skewed toward older residents, who were more available and accessible during survey hours. However, this is a disadvantage in that the limited inclusion of youth voices may obscure perspectives on modern, technology-driven waste solutions. Figure 2 below depicts how educational attainment varied significantly across the study sites

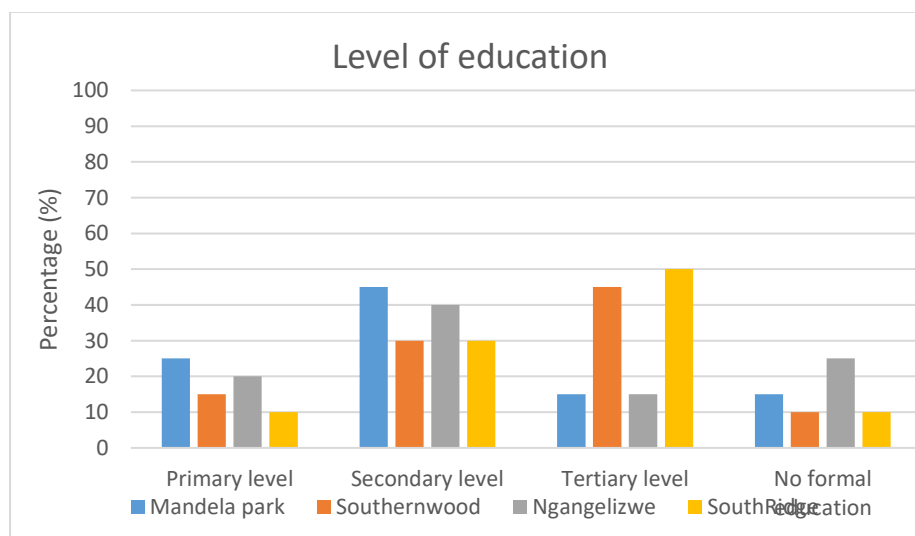


Figure 2: Level of Education

Source: (Field Survey, 2024)

Mandela Park had the highest proportion of respondents with only primary education, while Southridge and Southernwood, the more affluent areas, exhibited higher

levels of tertiary education. These differences are critical when assessing awareness and compliance with waste-related regulations. In areas with lower education levels, knowledge of municipal by-laws appeared limited, which may partially explain higher rates of illegal dumping. In a world that is confronted with climate change, pollution, deforestation, biodiversity loss, and other environmental problems that call for quick and continuous response (Samaresh, 2024), education becomes a vital instrument that raises environmental consciousness and gives people the information and abilities they need to successfully handle these issues. Environmental awareness education involves more than just knowledge transfer; it also involves behavior and attitude change. In contrast, residents in Southridge and Southernwood demonstrated a stronger grasp of formal waste protocols, likely supported by both their education and greater access to resources. Developing countries do face challenges with high rates of poverty, social marginalization, and a lack of formal education and environmental awareness. However, education alone does not ensure compliance. In Ngangelizwe secondary education was common but enforcement success also depended on supportive infrastructure and service availability. This finding underscores the multifaceted nature of environmental behavior, where knowledge must be matched by infrastructure availability and municipal support.

Household size also emerged as a significant variable influencing waste disposal practices. Middle-income areas such as Mandela Park and Ngangelizwe generally had households with 4–6 individuals, while Southernwood and Southridge were characterized by smaller household sizes, typically 1–3 people. Nonetheless, in both contexts, instances of larger household occupancy, particularly in rental properties, were recorded. Larger households make waste management difficult. Nahman et al. (2021) indicated that because of urbanization, population expansion and economic activity, South Africa's solid waste problem is growing rapidly, but municipal service delivery is finding it difficult to keep up. The accumulation of domestic garbage within settlements has an impact on the health of people who live mostly in low-income areas, even if this waste stream typically consists of [sometimes informal] business waste, building and demolition debris, and garden refuse. These patterns suggest that enforcement strategies must consider both social structures and housing dynamics to be truly effective.

Across all sites, participants' responses revealed significant variation in awareness and perceptions of municipal enforcement. While some respondents acknowledged the existence of by-laws and enforcement efforts such as signage, surveillance, or municipal patrols, many expressed skepticism about their effectiveness. In areas with visibly high dumping rates, residents often attributed the problem to insufficient monitoring, irregular waste collection, and a general lack of penalties for violators. Although the presence of enforcement strategies may be strong, their effectiveness tends to be very uneven across social-economic groups, the disparity largely attributable to differences in awareness, signing up of resources, and the capacity of the institution. Implementing these deficits requires more holistic program on a community-by-community basis and long-term commitment in terms of investing in education and service delivery.

5.1. The Enforcement Strategies Employed by KSD LM to Prevent Illegal Waste Dumping

The municipality implemented the following strategies: surveillance cameras, frequent patrols conducted by enforcement teams, the publicly set reporting systems, a fine and punishment system, the awareness campaigns within the community, the cleaning up the area, the supply of skip bins, and sharing the official notices. All these measures were meant to work towards striking a balance between punitive measures and preventive measures, which are meant to influence behaviors associated with waste-disposal in different segments of the community. Figure 3 illustrates an officer of the municipality offering a fine due to illegal dumping.



Figure 3: Municipal Officer Issuing a Fine for Illegal Dumping.

Source: Photo taken by Ntlangula, Field Survey 2024

Municipal solid waste management (MSWM) success depends upon the facilitative governance environment determined by the social, economic and psychological aspects, namely, engagement of the people, policy making and the attitudes and behaviors of residents (Polasi, 2020). In this regard, National Policy on the Provision of Basic Refuse Removal Services to Indigent Households aims at making it easier to access at least basic service of refuse removal by low-income households free of charge. In this context, skip bins have proved to be a popular infrastructure-based intervention: being strategically positioned in strategic spots, and providing community members with a ready tool to undertake appropriate waste collection. In line with best practice, the success of skip bins relies on the fact that they must offer reliable collection plans and generalized community education on a community-wide basis.

Perceptions gathered from surveyed residents across four locations, namely Mandela Park, Ngangelizwe, Southernwood, and Southridge, highlight the multifaceted causes of illegal dumping. These areas span middle- and higher-income communities, offering a comparative lens through which to understand enforcement effectiveness. In middle-income areas such as Ngangelizwe and Mandela Park, the most cited driver of illegal dumping was the inadequate provision of municipal waste services. This factor was reported by 85% of respondents in Ngangelizwe and 75% in Mandela Park, compared to only 10% in Southernwood and 6% in Southridge. Zondi et al. (2023) argue that compared to urban settings, local government operations are quite limited in several South African small towns. This is because rural regions are less inhabited, some are governed by traditional authority, and other municipalities lack the funding necessary to provide services like garbage collection. Because they lack the financial resources to carry out operations like local government, areas under traditional authority do not provide essential services. This is because traditional authorities are not financially supported by the political administration and do not collect taxes from the rural population.

Another key concern identified across all study areas was the infrequency of waste collection services. In qualitative interviews across several low- and middle-income neighborhoods in Cape Town, most interviewees described long-term inefficiencies in the collection of waste. The highest observed frequency of the phenomenon was in Mandela Park (90 percent of the respondents), Ngangelizwe (75 percent), Southridge (65 percent), and Southernwood (50 percent). This geographic uniformity implies that these problems are not the result of social-economic standing but instead are caused by failures in organizations. Services are often interrupted in the province due to financial shortage, poor logistical performance, and municipal incompetence. Households in all income levels are affected by poor scheduling, as well as the maintenance of refusal vehicles and the consistent understaffing of operating units. A third important obstacle is the lack of compliance with by-laws, predominant in middle-income neighborhoods: 65 percent of the respondents in Ngangelizwe and 45 percent in Mandela Park mentioned this concern, compared to 5 percent and 8 percent, respectively, in Southernwood and Southridge. This

disparity is explained by differences in the level of awareness and enforcement as well as level of community participation. Table 1 below summaries respondents' perceptions on the effectiveness of enforcement strategies.

Table 1
Perceptions on the Effectiveness of Enforcement Strategies

	AREA			
	Mandela Park	Southridge	Ngangelizwe	Southernwood
Effective	5	14	8	16
Not Effective	15	6	10	4
Not Sure	0	0	2	0

Respondents also identified broader socio-economic drivers, including financial hardship, urban population growth, and housing density, as contributing to illegal dumping. These factors were reported by 65% of respondents in Ngangelizwe and 45% in Mandela Park, compared to only 4% in Southernwood and 2% in Southridge. Kubanza (2025) asserts that most South Africans still have difficulty getting regular waste collection services, especially in communities with low incomes. 38% of the residents are reportedly without access to garbage pickup services. Without official waste collection, people typically search for alternative ways, which might not be the best course of action. According to Debrah et al. (2021), due to resource limitations, a lack of infrastructure and vehicles, poor route planning, a lack of technical know-how, and insufficient environmental education and awareness, the majority of low- and middle-income countries are unable to offer efficient SWM collection services.

Enforcement efforts must be contextualized within the socio-economic realities of each area. While punitive measures such as fines and patrols may function as immediate deterrents, long-term success hinges on consistent service delivery, infrastructure development, and inclusive public engagement. The challenges of illegal dumping are deeply rooted in inequality and require an integrated approach that balances regulation with accessibility, education, and equitable resource distribution.

5.2. Community Awareness of Municipal By-Laws to Prevent Illegal Waste Dumping

Niyobuhungiro and Schenck (2022) opined that the majority of the intended waste management objectives will require effective stakeholder participation and mutual understanding. All parties concerned must have a thorough understanding of the problem before any changes can be implemented to modify social conditions. Thus, municipal by-laws ought to be communicated to all stakeholders.

Awareness of enforcement patrols by municipal police was generally high across all areas but more pronounced in Southernwood (90%) and South Ridge (75%). This suggests a stronger and more visible municipal presence in these areas. Senekane (2024) alluded that instilling the 4Rs in the community would encourage the use of contemporary technology while addressing environmental contamination and the consequences of climate change. Illegal dumping in unapproved locations highlights the fact that the municipality in the research region should educate the local population as part of the solution to illegal dumping, which cannot be only attributed to unemployment. While awareness levels were somewhat lower in Ngangelizwe (60%) and Mandela Park (45%), these figures still reflect some degree of visibility. However, the reduced presence or lack of communication around patrols in these areas may contribute to public perceptions of weak enforcement.

Fines and penalties as deterrents were widely recognized in higher-income areas, with South Ridge (90%) and Southernwood (75%) respondents reporting awareness of these measures. Conversely, only 15% of respondents in Ngangelizwe and 30% in Mandela Park were aware of the use of fines and penalties. This disparity suggests uneven communication and possibly inconsistent application of punitive measures across socio-economic groups. Generis Global Legal Services (2025) asserts that depending on the infraction and the environmental impact, fines for environmental infractions in South Africa can range from thousands to millions of rands. For example, unlawfully disposing of hazardous waste can result in fines of up to R5 million, while contaminating waterways can

lead to fines of R1 million or more. Although these developments show progress, it is still unclear how effective they are overall at preventing infractions. To determine if increased fines and active prosecutions result in actual behavioral changes among businesses and individuals, ongoing evaluations are essential. In addition to being punitive, the objective is to foster a culture of sustainability and respect for South Africa's abundant natural resources.

Clean-up drives appeared to be more familiar to respondents in middle-income areas, with Mandela Park recording a 25% awareness rate and Ngangelizwe 20%, while Southernwood (8%) and Southridge (5%) showed significantly lower levels of recognition. This suggests that community-driven initiatives are more prominent in areas where municipal services may be limited or inconsistent. Rajwar et al. (2023) highlights that integrating diverse stakeholders, including minority or marginalized communities, into decision-making processes allows urban initiatives to meet their unique requirements while ensuring inclusive and fair development. The rehabilitation of illegal dumping sites was moderately recognized in middle-income communities, particularly Ngangelizwe (50%) and Mandela Park (35%) where past environmental degradation may have prompted active restoration efforts. In contrast, Southernwood (10%) and South Ridge (20%) reported minimal awareness. Khuluse & Leonard (2024) posit that regular awareness-raising efforts can help address the issue of illegal dumping. More regular waste collection must be implemented to reduce the problem of illegal dumping. If necessary, communities must have easy access to formal waste disposal, and biweekly or more frequent collections could be explored. Community awareness programs recorded the lowest levels of recognition across all surveyed areas. Strikingly, no respondents in South Ridge or Southernwood reported awareness of such programs. In Mandela Park, awareness stood at 25%, and in Ngangelizwe, it was just 15%. In middle-income communities, limited engagement may be attributed to inadequate program visibility or poor alignment with local needs. Nevertheless, the generally low awareness levels suggest a pressing need for improved outreach and tailored education campaigns. Community members in the study areas tend to conform to their neighbor's behavior when the municipality fail to collect refuse and resort to illegal dumping.

In contrast to the limited familiarity with formal awareness programs, public reporting mechanisms showed higher recognition in higher-income areas. South Ridge (80%) and Southernwood (70%) respondents reported substantial awareness, reflecting a strong culture of civic engagement. Thelma (2024) stipulates that civic education, often referred to as citizenship education, helps people develop knowledge, comprehension, social skills, disposition, virtues, and values that make them personally fulfilled and ready to contribute positively to society. Public awareness of local government concerns and institutions is increased by successful civic education initiatives. In Mandela Park (10%) and Ngangelizwe (15%), public reporting was far less familiar, indicating potential gaps in digital access or empowerment.

In middle-income communities, interpersonal communication through community members emerged as the most common source of information. Approximately 65% of respondents in Mandela Park and 70% in Ngangelizwe reported learning about by-laws through word-of-mouth. While this reflects strong community networks, it also raises concerns about the accuracy and reliability of information. Public posters were found to be a widely used method in all four areas. Ngangelizwe reported the highest usage (90%), followed by Mandela Park (70%), and both Southernwood and South Ridge at 50%. Posters remain a relevant and effective means of outreach in public spaces, particularly where digital communication may be limited. According to Kuehne et al. (2018), the positive outcomes of the proposed approaches to regional development through social media are also largely predetermined by the relevance, clarity, and timeliness of the information presented.

Even though encouraged, awareness and educational programs in all study sites were chronically underutilized irrespective of evident potential. In Southernwood, none of the respondents said that they were involved in such initiatives. In South Ridge and Ngangelizwe, comparative values were 5 % in each case. Mandela Park was the only registration area where moderate participation was recorded 10 % but still, the awareness was low. The low turnover is probably due to a poor recruitment process, a lack of funds,

and a general lack of interest on the part of citizens. Jutta and Lamidi (2023) advise that to establish and maintain government globally, community engagement is a crucial component. It establishes a forum for critical interaction between the public and the government. Communities are empowered through community involvement when they are given the chance to discuss their vision, including the kinds of services they should receive, with their council and other municipal leaders. Thus, it serves as a channel for community members to participate in the creation of policies and the process of making decisions. Social media and broadcasting emerged as highly effective tools for communicating by-law information across all socio-economic areas. Respondents in Southridge (85%) and Southernwood (75%) showed the highest commitment, followed by Mandela Park (65%) and Ngangelizwe (50%). This broad reach highlights the growing role of digital platforms in municipal communication strategies. This can be a very powerful approach, especially for the youth to lead behavior change campaigns on illegal dumping since the majority of them are active on various social media sites.

5.3. Effectiveness of Enforcement in Deterring Illegal Waste Dumping Activities

Community members from higher-income areas such as Southridge and Southernwood largely view these enforcement strategies as effective. In South Ridge, 14 respondents found the current strategies effective, compared to six who did not. A questionnaire conceived in the wealthy Southernwood area produced the following data: 16 respondents agreed with the effectiveness of municipal waste-management systems but only four respondents recorded them as shortages. The results therefore suggest that there is an overwhelming belief in the quality of waste-management infrastructure and enforcement tool in this segment. This is also probably due to more properly endorsed municipal services, stronger enforcement activity, and enhanced means of communication. Moreover, these neighborhoods have the potential to exercise greater political power thus getting a better supply of services and responsiveness to the local governmental bodies.

Comparatively, middle-income respondents in Mandela Park and Ngangelizwe districts assumed highly critical stances to prevailing enforcement actions. In Mandela Park, 15 of interviewees assessed the initiatives to be ineffective, five people rated the initiatives highly. In Ngangelizwe, the trend was also the same with 12 participants assessing enforcement as ineffective, eight having a positive view and two were undecided. The data shows that there is a strong imbalance between how the municipal interventions are conducted in these regions as well as the extent to which they are seen as legally acceptable. According to Asha and Makalela (2020), local governments in South Africa have been using integrated development plans (IDP) to provide essential services in their areas. However, in most of the municipal jurisdictions, the aspect of service delivery continues to be an issue. Water, power, sanitation and garbage disposal, basic amenities in a household are also a major concern. Social unrest and political complexities have been created by some residents who have had to engage in intermittent violent protests to show their disappointment.

The different interpretations can also be ascribed to the varying degrees of confidence in local authority. Mandela Park and Ngangelizwe residents often feel that police operations are not seen as effective and can be insufficient, late, and much more often symbolic rather than substantive. This perception is further compounded by weak communication strategies. The two Ngangelizwe respondents who reported being unsure of enforcement effectiveness may exemplify this broader issue of disconnection between the municipality and the people it serves. The spatial distribution of illegal dumping activities offers further insights into enforcement efficacy. Figure 4 reveals the locations and statuses of 42 identified dumping sites across the study areas, along with the placement of skipper bins and notice boards.

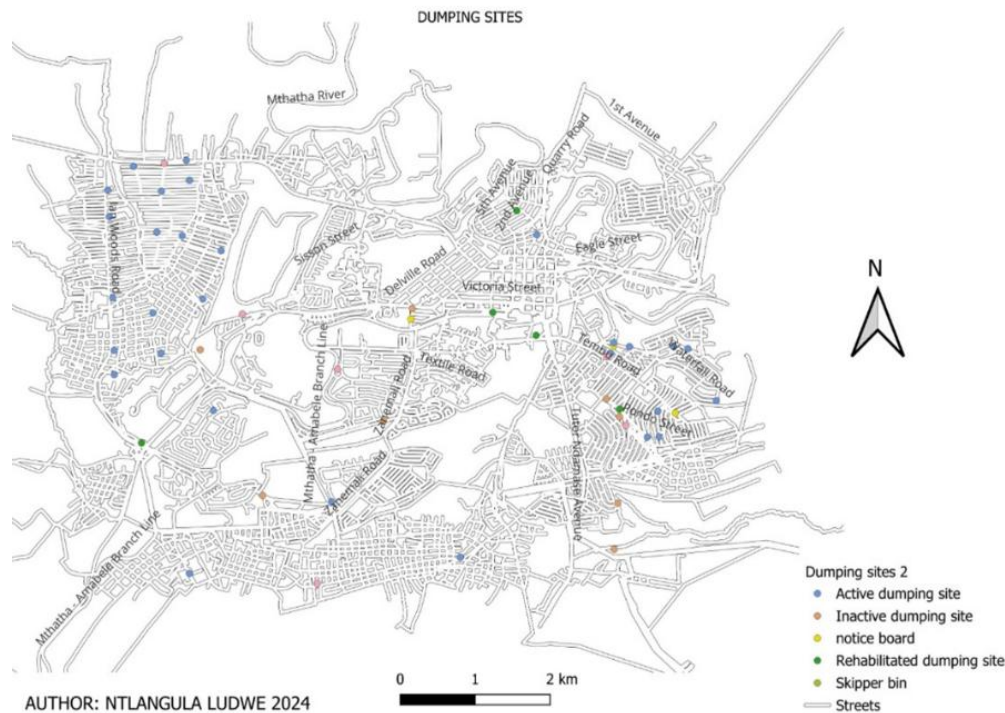


Figure 4: Distribution of Dumping Sites in all 4 Areas

Source: Field Survey Author creation (Ntlangula L, 2024)

Of these 42 sites, 29 are classified as active, eight as inactive, and five as rehabilitated. Most of the active dumping sites are in Mandela Park and Ngangelizwe, underlining the severity of the problem in middle-class communities. Interestingly, while most skipper bins are also concentrated in Mandela Park and Ngangelizwe, the high number of active dumping sites suggests that the presence of infrastructure alone is insufficient. If community members are unaware of proper disposal methods or find the bins difficult to access or use, illegal dumping will persist despite the physical infrastructure. The presence of inactive dumping sites offers a glimpse into potential improvements or shifts in community behavior, although the risks of recurrence remain high if these areas are not consistently monitored. The dynamics in Mandela Park and Ngangelizwe suggest that even inactive dumping sites can regress without adequate follow-up from authorities and community leadership.

The restoration of five former disposal sites, many of which have been turned into parks or other green areas, is one of the more encouraging achievements. This change is indicative of a positive trend toward community involvement and sustainable land usage. Furthermore, involving locals in the daily maintenance and administration of these spaces can increase ownership and discourage future abuse. Despite these infrastructure and rehabilitative efforts, communication remains a weak point in the overall strategy. Only two noticeboards were found across all four locations, significantly limiting residents' exposure to information about waste management rules, penalties, or available services. This lack of signage diminishes the visibility and authority of the by-laws themselves. According to Adedara et al. (2023), a combination of environmental, social, technical, and technically skilled human resources, financial and technological resources, resource recycling, environmental pollution awareness programs, and public participation are all necessary for effective waste management practices. Due to a lack of resources, municipal solid waste (MSW) is still a problem in Africa and is frequently not given the highest priority. Figure 5 below provides further analysis by overlaying a 500-meter buffer zone around existing skipper bins.

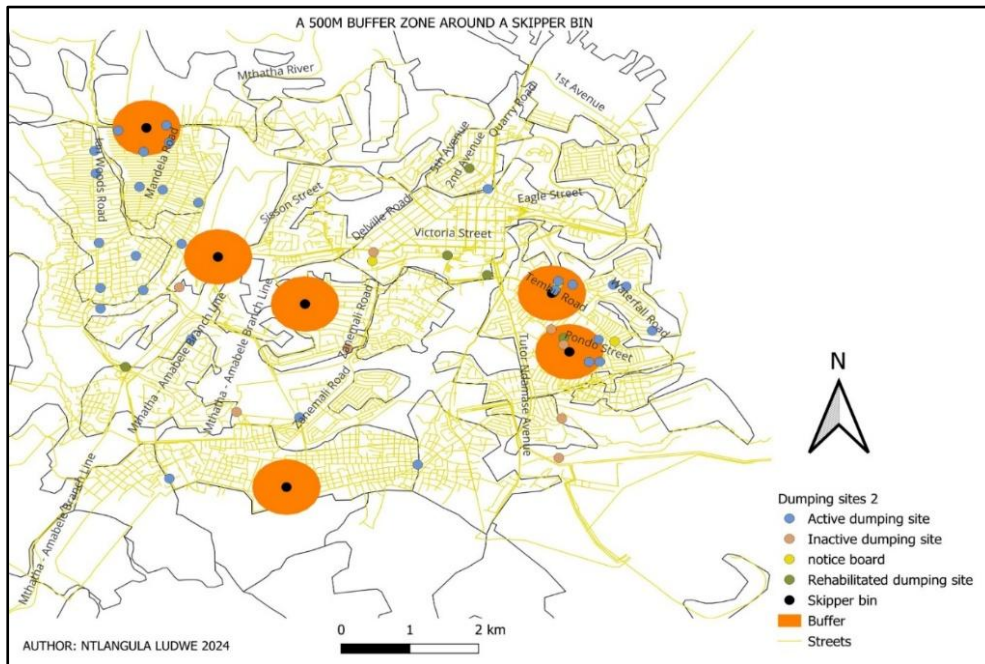


Figure 5: A Map Showing a 500 Metre Buffer Around a Skipper Bin
Source Field Survey, Author Creation (Ntlangula L, 2024)

This spatial tool allows for an assessment of accessibility and its potential influence on illegal dumping behavior. According to Maalouf and Mavropoulos (2023), in Sub-Saharan Africa, the amount of municipal solid waste (MSW) generated and carelessly dumped has increased to an all-time high. Workers face the danger of physical and mental health problems because of collecting MSW. MSW collectors' employees are continuously put through physical labor cycles that include pushing, dragging, carrying, and lifting. Looking at the map above, we can say that the municipality in the study area is constrained in terms of human resources since the area is highly populated. However, the presence of active dumping sites within this buffer zone in Mandela Park and Ngangelizwe indicates that proximity alone is not a sufficient deterrent.

Importantly, the data also suggests that punitive measures for illegal dumping should be applied with caution, particularly for individuals living outside the 500-meter threshold. Households beyond this range may face legitimate barriers to accessing disposal sites, such as physical disability, lack of transportation, or economic hardship. While enforcement strategies appear more effective in higher-income areas, middle-income communities continue to struggle with illegal dumping due to infrastructural, communicative, and socio-economic challenges. A more integrated approach combining strategic placement of waste infrastructure, consistent community education, clear signage, and context-sensitive enforcement is required to ensure that municipal by-laws on waste dumping are not only implemented but internalized and upheld across all community sectors.

6. Conclusion

This study examined the effectiveness of enforcement strategies for managing illegal waste dumping across contrasting socio-economic contexts within the King Sabata Dalindyebo (KSD) Municipality, specifically comparing the middle-income areas of Mandela Park and Ngangelizwe with the higher-income areas of Southernwood and Southridge. There is a significant gap between the actual and perceived effectiveness in the delivery of municipal by-law enforcement across KSD Municipality, which is significantly affected by the socio-economic status, relative population density, access to infrastructure and community interaction. Higher-income communities exhibit more effective practices of waste enforcement, which can be attributed mainly to the effectiveness of municipal provision of services, stronger communication systems, and increased civic obedience. They have regular collection of waste matter, the pursuance of enforcement, and an informed population that is enlightened and enabled to adhere to regulations. On the other hand, middle-income areas like Mandela Park and Ngangelizwe are facing consistent problems

like ad hoc waste collection, non-equitable access to disposal facilities, inadequate propagation of information and low confidence in local authority enforcement. Despite the consistency of the enforcement strategies implemented in the study areas, the overall effectiveness of these strategies is undermined by the overemphasis of the punitive strategies along with lack of community-based strategies. The continued existence of working illegal-dumping sites, even on wastage nearby facilities, signify that current regulatory systems mainly touch on symptomatic reasons as opposed to structural root causes of non-compliance. Although fines, patrols, and mechanisms that enable communities to report remain as means of deterrence, they are not sufficient in the absence of parallel measures to mobilize, educate, and empower communities. Therefore, the study finds that the KSD Municipality has been performing poorly at enforcing illegal dumping, especially at middle-income communities. The regulatory framework does not consider contextual difficulties like inefficient access to waste facilities, low awareness, and low community involvement in the problem. That is why solutions should provide more than an increase in enforcement; instead, they should adopt an all-rounded, thoroughly integrated model that combines expansion of infrastructure with community-based governance and enduring involvement of the people.

6.1. Recommendations

A multidimensional and community-based method is necessary to enhance the efficacy of the strategy of waste management and minimize the risk of the illegal dumping of waste in the KSD Municipality. It is based on the identified disparities and challenges across the four areas of study that the following recommendations are suggested:

6.1.1. Increase Frequency of Waste Collection

In the middle-income sectors like Mandela Park and Ngangelizwe, the existing waste collection time are not sufficient to the demand of population density and waste volumes generated in the areas. This insufficiency contributes to overflowing bins and subsequent illegal dumping. The municipality should prioritize increasing the frequency of waste collection in these areas to reduce reliance on informal disposal practices. More consistent service will not only improve cleanliness but also signal municipal commitment, fostering greater public cooperation and responsible disposal behavior.

6.1.2. Expand Waste Disposal Infrastructure

A strategic expansion of waste disposal infrastructure, particularly the deployment of more skip bins and designated dumping sites, is necessary to meet demand in high-density areas. Placement should be informed by spatial analysis and community consultation to ensure accessibility for all residents. Importantly, the provision of infrastructure must be paired with clear signage and public education campaigns to promote correct usage and discourage dumping near, rather than into, these facilities.

6.1.3. Strengthen Law Enforcement Presence with Community Support

Although a stronger law enforcement presence can act as a deterrent, it must be implemented in partnership with community outreach. Additionally, officers should be visible, accessible, and trained to engage constructively with the public. Enforcement strategies should not rely solely on punitive measures but should incorporate a restorative justice approach which seeks to understand and address the social and economic drivers of non-compliance. Such a twofold approach of enforcement and support will create a culture of cooperation instead of confrontation.

6.1.4. Establish Continuous Monitoring and Evaluation Systems

There is a necessity to guarantee adaptive and responsive waste management plans, such as the introduction of permanent monitoring and evaluation mechanisms by the municipality. The systems must incorporate frequent inspection of the hotspots of dumping, gathering of data about the efficiency of service delivery, and feedback channels to incorporate resident opinion. Such evidence-based practice will enable the municipality to streamline policies, apportion resources and be proactive on emerging challenges.

Accountability and report transparency on progress can also increase the level of confidence.

6.1.5.Prioritize Community Engagement and Education Programs

People's participation needs to be embedded as one of the main foundations of waste management mechanisms. Local ownership of environmental issues can also be boosted through neighborhood clean-up campaigns, school-based education workshops and recycling competitions. The classroom lesson must focus on environmental and health dangers of illegal dumping and shift to alternative disposal methods. The partnership with schools, faith-based organizations, and local leaders can provide compound effect across the community, as these individuals are the ones who can instill sustainable practices in individual households.

6.1.6.Improve Public Awareness and Reporting Mechanisms

Lastly, awareness-raising campaigns must be increased through various means of communication such as social media, posters placed in the community, community radio communications, and mobile alerts. This should involve public reporting portals which should also be offered with significant publicity and without identifying the user. The empowered residents will more readily enter the system to report violations that constitute a decentralized network of enforcement that enlarges municipal capacity.

An effective plan to control illegal dumping in the KSD Municipality should be more than regulatory. It involves a long-term engagement on infrastructure building, inclusive governance and transformative popular participation. The municipality can fully enforce, educate, and empower in order to foster long-term compliance and a cleaner healthier environment among all its residents only through a balance between the three approaches.

Author Contributions

Ludwe Ntlangula: Lead author contributed significantly to the paper through conceptualization, study design, data collection, presentation and analysis. The study is derived from his BSc Honors in Geography research project, Department of Biological and Environmental Sciences, Walter Sisulu University, South Africa.

Zanele Xelelo: together with LN conceptualized the initial draft of the paper. She was LN's research supervisor, contributed to literature review for this paper and discussion of findings.

Leonard Chitongo: Corresponding author prepared the draft paper. Contributed immensely to literature review and restructuring results and discussion of the findings. He further attended to all reviewer comments.

Conflict of Interests/Disclosures

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