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Household Solid Waste Awareness and Practices among Residents of Windhoek, Namibia

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Abstract

This study explores household solid waste management (HSWM) practices and awareness among residents of Windhoek West, a rapidly urbanizing constituency in the Khomas Region of Namibia. Employing a descriptive methodology, the research investigates the interplay between public awareness, regulatory frameworks, and the availability of waste management facilities to assess their impact on waste management behaviors. Our findings indicate significant gaps in both knowledge and infrastructure that hinder effective waste management. The study reveals that while there is a high willingness among residents to engage in recycling and waste reduction, actual practices are limited due to inadequate facilities and lack of stringent enforcement of waste policies. This research identifies key factors that influence waste management practices, including demographic characteristics and access to waste management facilities. It also proposes actionable strategies such as expanding recycling and sorting facilities, enhancing educational campaigns tailored to local needs, and implementing regular enforcement mechanisms. These strategies are aimed at improving compliance with waste management protocols and fostering a culture of environmental responsibility. The results of this investigation show the critical role of ongoing education and infrastructural improvement in bridging existing knowledge gaps and facilitating effective waste management practices. This research lays a foundational step toward enhancing sustainable urban development and effective waste management in Windhoek, providing valuable insights for policymakers, community leaders, and stakeholders engaged in urban environmental management.

Keywords

Household Solid Waste Management (HSWM), Public Awareness, Waste Segregation, Windhoek West, Recycling Facilities

1. Introduction

Namibia's capital, Windhoek, is a prime example of the challenges associated with handling domestic solid waste in a setting that is quickly urbanizing, as is the case in many developing countries. The efficiency of larger waste management systems greatly depends on the waste management techniques implemented at the household level, which are the subject of this study [1] [2]. Households are essential in implementing waste segregation, recycling, and reduction policies since they are the main producers of municipal solid waste. These procedures are essential for improving environmental sustainability and public health outcomes in addition to making waste management systems more operationally efficient [3].

The theory of planned behavior, which contends that attitudes toward environmental issues and understanding of those issues may strongly predict waste management practices, serves as the theoretical foundation for this study. This idea emphasizes how crucial it is to support behavioral change by doable actions in addition to raising community knowledge [4]. To determine and enhance the effectiveness of waste management programs, it is important to evaluate Windhoek's knowledge levels as well as the accessibility of waste management facilities.

Residents' awareness of solid waste management is crucial since it affects their participation in recycling and household solid waste reduction programs. It is a widely held belief that improved waste management techniques result from increased awareness. In fact, people are more likely to adopt sustainable waste habits when they are aware of the negative effects that inappropriate waste management has on the environment, human health, and the economy [5]. The body of research suggests, nevertheless, that raising awareness alone might not be enough to effect meaningful change. In order for awareness to become action, it has to be combined with doable steps that make these behaviors easier to embrace [6]. Adequate recycling facilities, frequent garbage collection services, and incentives for waste management program participation are a few examples of these pragmatic approaches [7].

The implementation of environmental educational initiatives that teach useful skills for solid waste reduction and segregation in addition to increasing awareness are crucial. Communities may foster an atmosphere where sustainable activities are not only promoted but also readily implemented by putting these supportive measures into place [8]. This all-encompassing strategy guarantees that raising awareness results in observable advancements in waste management,

encouraging a sustainable culture within communities and supporting larger environmental preservation initiatives [9].

Because of poor infrastructure, low public knowledge, and lax regulatory framework, household solid waste management in urban areas is severely problematic in developing nations [10]. These issues are made worse in many African cities by the rising amounts of garbage produced by expanding populations, which frequently surpass the capacity of the current waste management systems. The use of inappropriate disposal techniques, such burning and open dumping, is common and presents serious health hazards in addition to seriously degrading the ecosystem [11] [12].

This study aims to critically assess the levels of awareness and current practices related to household solid waste management among Windhoek West residents. It seeks to identify key factors influencing these practices and propose actionable strategies to enhance the city's waste management framework. By understanding the interplay between public awareness, regulatory frameworks, and the availability of waste management facilities, this research intends to offer insights into developing integrated strategies that not only address the existing challenges but also promote sustainable urban development.

Significance of the Study

The findings of this study offer valuable insights into the current practices and challenges associated with household solid waste management in Windhoek. These insights are critical as they provide a comprehensive understanding of the effectiveness of existing waste management systems and the behaviors of local residents towards waste handling. The detailed analysis presented in this study should serve as a robust foundation for the development of evidence-based policies, regulations, and urban planning strategies.

2. Materials and Methods

2.1. Study Area

This study investigates the municipal household solid waste management in Windhoek West, a constituency within Windhoek, Namibia, spanning 208.08 square kilometers and hosting a population of approximately 59,907. The area is notable for its demographic diversity, with residents from varied ethnic, cultural, and socioeconomic backgrounds, which influence waste generation patterns, disposal practices, and engagement in waste management initiatives [13]

Economically, Windhoek West is characterized by middle to high-income levels, which significantly impact waste management behaviors [13]. Geographically, Windhoek's location on the Khomas Highland plateaus, at about 1700 meters above sea level [14], poses unique challenges for urban expansion and infrastructure development, particularly for waste management systems [15].

The Division of Solid Waste Management (SWM) within the Municipality of Windhoek oversees the collection, transportation, and disposal of all solid waste

within the city. Each household is provided with a wheelie bin for temporary waste storage until collection. Organic materials, such as garden refuse and building rubble, are separated and processed at dedicated facilities. Recyclables are sent to sorting centers like Rent-A-Drum, while non-recyclable waste is transported to the Kupferberg landfill for final disposal. This systematic approach ensures environmentally responsible management of municipal solid waste in Windhoek [15].

2.2. Methodology

This research utilized a descriptive methodology to investigate the awareness levels of Windhoek West residents regarding household solid waste management. A qualitative approach was adopted, employing questionnaires as the primary instrument for data collection. This qualitative framework enabled a detailed examination of residents' attitudes, practices, and challenges concerning solid waste management. The approach was selected to provide an in-depth understanding of the myriad factors that influence waste management behaviors and systems in an urban environment. Data collection was conducted over a four-week period, from October 22 to November 13, 2023, ensuring comprehensive analysis and robust findings.

2.3. Study Participants

In this study, data collection was strategically designed using both purposive and random sampling techniques to effectively meet the research objectives. Purposive sampling, a non-probability method, was employed to selectively identify participants who exhibited characteristics pertinent to the research goals, making it particularly effective for targeting the desired demographic for the online survey. This survey was administered using KoboToolbox, an open-source platform that facilitates data collection, management, and visualization.

All homeowners in the Windhoek West neighborhood were considered eligible participants, based on the assumption that they possessed essential knowledge about household solid waste management and disposal practices. This criterion acknowledged homeowners as key stakeholders, capable of providing valuable insights into local waste management practices, including attitudes towards waste disposal.

To complement the purposive sampling, random sampling was also implemented to enhance the diversity and representativeness of the sample. This approach did not follow a predetermined order for participant selection; rather, any interested homeowner from Windhoek West was eligible to participate. This method leveraged the natural willingness of participants to engage, which likely increased both the response rate and the reliability of the data collected. The combination of these sampling strategies played a crucial role in facilitating a comprehensive assessment of household solid waste management practices in the Windhoek West area.

2.4. Material for Data Collection

A detailed examination of the literature guided the construction of the Kobo-Toolbox online survey questionnaire, guaranteeing its comprehensiveness and relevance to the study's goals. The survey was divided into three main areas, each of which was intended to collect certain kinds of information relevant to Windhoek West's household solid waste management.

The purpose of the questionnaire's first component was to gather sociodemographic information from the respondents. This comprised elements including age, gender, education level, size of home, and length of time spent living in Windhoek West. These data points were essential for deciphering the respondents' demographic profile and for assessing the data in light of other demographic variables.

In order to assess the participants' attitudes, awareness, and knowledge of municipal household solid waste practices, including recycling and current policies, the second section of the questionnaire consisted of multiple-choice questions. Furthermore, the participants' satisfaction with the household solid waste management system of the City of Windhoek was evaluated in this area. These inquiries were crucial for identifying trends in the inhabitants' attitudes and actions about garbage management.

Multiple-choice and open-ended questions were merged in the third and final phase of the survey. In addition to providing information about their personal solid waste management procedures, participants were invited to make recommendations for enhancements to the municipal solid waste management system. The inhabitants' desire to take part in garbage sorting efforts was also investigated in this section. Open-ended questions made it possible to gather qualitative information that would have enhanced the study's conclusions by providing more in-depth understanding of the inhabitants' viewpoints and experiences.

2.5. Data Collection Procedure

Prior to the main survey, a pilot survey was conducted to assess participants' comprehension of the questions and provide an opportunity for refining the questionnaire to better align with the research objectives. This preliminary phase was crucial for ensuring the clarity and relevance of the survey items.

The final online questionnaire was disseminated electronically to the residents of Windhoek West using emails and popular online platforms such as WhatsApp. Utilizing existing neighborhood watch WhatsApp groups proved effective in distributing the survey link widely and efficiently. Key figures within the Windhoek West community were initially approached to assist in identifying suitable platforms for the survey's dissemination, ensuring broader participation.

Participants were given the flexibility to complete the survey using either cell phones or computers, enhancing accessibility and convenience. The questionnaire comprised 25 questions, and the survey instructions clearly stipulated that

each participating household was to complete the survey once to ensure distinct responses. The primary respondents targeted were heads of households, with a directive for only one submission per household.

The survey successfully garnered 452 responses, believed to represent 452 unique households from the Windhoek West area. Throughout the survey process, there was ongoing communication between the researcher and participants. This continuous engagement was vital for addressing any difficulties participants encountered with the survey questions, ensuring clarity and improving the quality of the data collected. This approach not only facilitated effective data collection but also reinforced the reliability of the findings, contributing to a comprehensive understanding of household solid waste management practices within the community.

3. Results

3.1. Demographic Information

Given their decision-making responsibilities, Table 1 shows the preponderance of female respondents (59.1%) and older age groups (31 - 59 years), which are

Table 1. Socialdemographic information of participants.

Variable	Category	Count	Percentage (%)
Gender	Male	185	40.9
	Female	267	59.1
Age (Years)	18 - 30	72	15.9
	31 - 45	231	51.1
	46 - 59	149	33
	Over 60	0	0
Educational background	Uneducated	0	0
	Primary level	0	0
	Secondary level	15	3.3
	Diploma and above	437	96.7
Occupation status	Unemployed	22	4.9
	Employed	339	75
	Business/self-employed	91	20.1
Residential status	Own	110	24.3
	Rented	342	75.7
Residence duration (years)	Less than 1	31	6.9
	1 to 2	36	8
	3 to 4	77	17
	5+	308	68.1

important demographics in household solid waste management. With a high employment rate of 95.1% employed or self-employed and the majority having at least a diploma (96.7%), the community is both economically equipped to execute efficient waste management techniques and capable of comprehending complicated sustainability challenges. The adoption of long-term waste solutions may be hampered by the high ratio of renters (75.7%), however this effect may be mitigated by the fact that the majority have lived in their houses for more than five years. The opportunity for focused environmental education and the adoption of sustainable practices within the community is highlighted by this demographic profile.

3.2. Waste Management Awareness

The population of Windhoek West is largely informed, but there are substantial informational and infrastructural impediments. This is evident from Table 2's findings regarding people' awareness, attitudes, and participation with municipal household solid waste management. Even while 79.9% of respondents are aware that they generate garbage, only 23.9% completely comprehend waste management rules, and 64.8% have just a modest level of acquaintance with segregation techniques. Only 34.7% of respondents feel well-informed, and only a small percentage have easy access to recycling and sorting facilities, despite the strong willingness of respondents (86.7%) to recycle and sort. Moreover, a notable

Table 2. Level of awareness.

Variable	Yes		No		Not sure	
	Count	(%)	Count	(%)	Count	(%)
Mindful of household waste generation	361	79.9	0	0.0	91	20.1
Understanding of solid waste management policies	108	23.9	344	76.1	0	0.0
Familiar with solid waste segregation	293	64.8	122	27.0	37	8.2
Awareness of current MSW management initiatives	31	6.9	281	62.2	140	31.0
Willingness to participate in recycling and sorting	392	86.7	0	0.0	60	13.3
Availability of information on proper waste management	157	34.7	295	65.3	0	0.0
Access to recycling facilities	135	29.9	285	63.1	32	7.1
Availability of MSW sorting bins	53	11.7	345	76.3	54	11.9
Knowledge of existing penalties	23	5.1	353	78.1	76	16.8
Familiarity with incentives for solid waste sorting	54	11.9	375	83.0	23	5.0
Ability to correctly sort waste	256	56.6	131	29.0	65	14.4

lack of awareness regarding the consequences of non-compliance and the rewards associated with sorting may have an impact on the observance of waste management protocols.

3.3. Household Solid Waste Management and Practices

Table 3 shows that there are notable differences between the high knowledge and desire of Windhoek West inhabitants to participate in waste management methods and their actual activities. Although there is theoretical comprehension, there is still a low level of practical participation; just 10.8% of respondents regularly sort their garbage and follow recycling guidelines to a basic extent. Further undermining compliance is the lack of consistent enforcement; 87.2% report no fines for not segregating garbage, and 73.2% say that waste is rarely examined before collection. Furthermore, a significant portion of the population occasionally uses open fields (21.0%) or burns garbage (15.7%), indicating the persistence of inappropriate disposal practices.

4. Discussion

The current study was carried out to determine the level of awareness among the residents of Windhoek West regarding household solid waste management. Descriptive data was analyzed and summarized for this study. The analysis was done by first analyzing the sociodemographic information of the inhabitants of Windhoek West. The findings from the study conducted by Abushammala and Ghulam [9] revealed that demographics of the residents impacts on their awareness regarding solid waste management. To create effective, efficient, and sustainable waste management systems, social demographic data must be included

Table 3. Household solid waste management practice.

Practice	Always		Often		Sometimes		Never	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Household solid waste sorting	49	10.8	31	6.9	103	22.8	269	59.5
Failure to separate waste leads to fines	0	0.0	0	0.0	58	12.8	394	87.2
Waste is checked for sorting before collection	0	0.0	31	6.9	90	19.9	331	73.2
How often do you separate recyclable?	9	2.0	54	11.9	235	52.0	154	34.1
I compost organic waste at home	0	0.0	54	11.9	113	25.0	285	63.1
Reuse of plastic bags	126	27.9	72	15.9	108	23.9	146	32.3
I dispose of waste through waste collectors	322	71.2	85	18.8	45	10.0		0.0
I dispose waste to open field	40	8.8	58	12.8	95	21.0	259	57.3
I burn my accumulated solid waste	43	9.5	71	15.7	56	12.4	282	62.4

into strategy creation and waste management planning [10] [16]. The Windhoek West demographic profile offers crucial information that may be used to develop customized household solid waste management plans that improve sustainability and community involvement. The high employment rate and high level of education in the population point to a good ability to comprehend and apply sophisticated waste management techniques.

Recent studies have identified a significant positive correlation between the level of awareness on municipal solid waste management and an educated population. According to the research conducted by Fadhullah, Imran, Ismail, Jaafar and Abdullah [5] educated population possesses a heightened awareness that can be effectively leveraged to promote sustainable waste management practices. This assertion is further supported by empirical evidence from a study in Phnom Penh, Cambodia, which illustrates that enhanced educational attainment correlates positively with increased awareness and engagement in solid waste management activities [17].

Given the educational profile of Windhoek West's residents, it is plausible to advocate for targeted educational campaigns that extend beyond traditional academic settings into workplace environments. Such initiatives could significantly bolster consistent waste management practices across diverse life domains. By integrating sophisticated environmental education campaigns and workplace-based recycling programs, communities can foster a culture of sustainability that aligns with both global environmental standards and local developmental needs.

The participation of women in waste management is not only significant but also critical for the success of environmental sustainability initiatives. As indicated by recent research, women play a central role in household waste management, often being the primary managers of household duties. This position enables them to act as pivotal agents of change within their communities [18]. Table 1 in this study illustrates the substantial involvement of women, emphasizing their integral role in the success of recycling, waste reduction, and segregation initiatives.

Cultural norms in many societies assign the responsibility of household management primarily to women, positioning them uniquely to influence household behaviors directly. Therefore, targeting educational and awareness programs specifically at women can maximize the effectiveness of these initiatives. As they are typically the implementers of daily waste management practices, educating women not only enhances their knowledge and skills but also has the potential to catalyze broader community changes through the multiplier effect [19].

This study further supports the notion that when women are educated about environmentally responsible behaviors, these practices are more likely to be adopted by the entire household. Women often transmit these values to their children and other family members, thereby extending the impact of their knowledge and actions well beyond individual practices [6] [18] [20].

The analysis of residents' awareness, attitudes, and engagement in household solid waste management in Windhoek West reveals a considerable potential for enhancing existing waste management strategies. This potential can be realized through the implementation of comprehensive, community-focused educational programs. These programs are essential not only for bridging existing knowledge gaps but also for articulating clear waste management policies, the benefits of compliance, and the repercussions of non-compliance [6].

Awareness campaigns are crucial as they promote behavioral changes and foster more environmentally friendly attitudes through continuous education and positive reinforcement. The success of such campaigns is evidenced by the integration of environmental education into Japan's formal education system. By instilling environmental principles from an early age, Japan has developed a robust foundation for long-term environmental awareness and responsibility [8]. Similar approaches, adapted to meet specific national needs, have also been effectively implemented in other countries with advanced waste management systems [21] [22].

The detailed assessment identifies a critical shortfall in recycling and sorting facilities within the Windhoek West area. To address these deficiencies, it is essential to expand the local waste management infrastructure. This expansion should include the installation of accessible community recycling bins and the establishment of centralized sorting facilities, which will significantly enhance the efficiency and efficacy of recycling operations in the area.

Ensuring that these facilities are user-friendly and well-maintained is crucial for fostering correct and sustained use by the community. Such improvements are not only about providing infrastructure but also about promoting a culture of recycling through ease of use and accessibility [23].

The effectiveness of these infrastructural enhancements can be further augmented by the development of incentive programs. Developing incentive programs is an effective strategy to address knowledge gaps and promote efficient waste management practices. These programs, including municipal fee reductions, tax rebates, monetary rewards, and public recognition, raise awareness and encourage proper waste disposal and recycling. Financial incentives make environmentally friendly practices more attractive, while public recognition fosters community pride and broader engagement [24] [25] [26]. Public recognition through various forms, such as certificates, media features, and community events, has proven to be an effective means of encouraging and rewarding individual efforts [27]. By implementing such incentives, municipalities can motivate residents to adopt environmentally friendly practices, thereby reducing overall waste generation and promoting environmental sustainability [28].

The findings of this study from **Table 3** indicate a substantial discrepancy between the high levels of awareness and willingness to engage in waste management practices and the actual behaviors observed among residents of Windhoek West. This gap presents significant opportunities for improving waste management strategies through targeted interventions.

Despite the fact that awareness and willingness are high, the actual implementation of these practices falls short. This shortfall is partly due to the current lack of effective enforcement mechanisms, such as fines and routine waste checks, which could potentially enhance compliance with waste segregation and recycling practices [29]. Introducing regular enforcement mechanisms, including fines for non-compliance and routine checks before waste collection, could serve as a strong incentive for residents to adhere more closely to established protocols.

However, it is crucial to consider that enforcement strategies such as fines can have varied impacts. Some scholars argue that imposing fines for improper disposal might, paradoxically, negatively affect the attitudes and behaviors regarding household waste management [30]. This suggests that while enforcement can enhance compliance, it must be balanced with positive reinforcement strategies and public education to ensure that it does not lead to unintended adverse effects.

In the Windhoek West community, the persistence of improper waste disposal methods, such as burning waste and utilizing open fields, poses severe environmental and health risks. The combustion of domestic garbage releases a significant amount of particulates and black carbon, which not only degrades air quality but also poses a substantial health risk to the community, especially when exposure is prolonged [31]. The burning process emits various pollutants, including sulfur dioxide and nitrogen oxides, which are major contributors to acid rain and broader air pollution issues [32]. Globally, similar issues are observed, with improper waste disposal leading to increased respiratory illnesses, environmental degradation, and socio-economic disparities [33] [34]. Environmental degradation affects water quality, soil fertility, and biodiversity, perpetuating socio-economic disparities as marginalized communities often suffer the most from waste mismanagement [33].

To address these critical issues, it is vital to cultivate a shift in community attitudes towards more ecologically responsible waste disposal methods. This transformation can be effectively facilitated through a comprehensive educational approach. By educating the community about the detrimental effects of improper disposal on both the environment and public health through formal education, seminars, and extensive media outreach including social media engagement behavioral changes can be encouraged. These educational initiatives can serve as powerful tools to promote environmental awareness and foster sustainable practices [6] [30].

Diverse environmental education programs have been successfully implemented, achieving notable outcomes. For example, the Nature Education School (NES) in Malaysia, the Adiwiyata Mandiri Program in Indonesia are exemplary cases of successful environmental education initiatives. These programs highlight the importance of strategic planning, community involvement, and adaptive management in fostering environmental awareness and sustainable beha-

viors [35] [36]. Integrating these approaches into community education can significantly enhance the effectiveness of environmental education efforts.

5. Limitation

Windhoek West, one of the ten constituencies in the Khomas Region where Windhoek, the capital city, is located, served as the focal point for the recent study on household solid waste management. Given the short duration of this study, it was not possible to cover the entire city of Windhoek comprehensively. Therefore, the findings from Windhoek West should not be generalized to represent the overall status of waste management within the entire city. These findings provide only a preliminary insight into local waste management practices and may not accurately capture the full spectrum of issues or potential areas for improvement throughout Windhoek.

Given that this study is the first of its kind in Windhoek West, there is a pressing need for further research. Future studies should include a detailed household solid waste audit across different constituencies of Windhoek to gain a more accurate and comprehensive understanding of the actual waste management practices employed. Such studies will be essential to developing targeted interventions that address specific waste management challenges identified across the city.

6. Conclusion

This study has evaluated the awareness and practices related to household solid waste management in Windhoek West, identifying key issues such as lack of awareness, inadequate facilities, and weak regulatory frameworks. It proposes practical strategies including the expansion of recycling and sorting facilities, enhanced educational programs, and stricter enforcement measures. Emphasizing educational initiatives, particularly targeting women who play a central role in household waste management, is crucial. These strategies aim to increase awareness, promote sustainable waste management practices, and foster a culture of environmental responsibility. The study provides a foundation for sustainable urban development and effective waste management in Windhoek, urging policymakers and community leaders to invest in educational and infrastructural solutions for a cleaner, healthier urban environment.

Conflicts of Interest

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

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