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TITLE: AN ASSESSMENT OF THE EFFECTS OF HIGH POPULATION DENSITY ON SOLID WASTE MANAGEMENT. A CASE STUDY OF CHIVHU.

MUVUTI SHINGIRIRAI

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DECLARATION

Registration number: **B201135B**

I Shingirirai Muvuti do hereby declare that this work related project is my original work and has not been submitted before. All the information derived from other sources is indicated in the project.

Student name: Shingirirai Muvuti

Signature: 

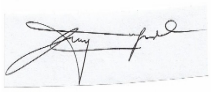
Date: 11 October 2024

Supervisor: Dr Dzvene

Signature:  ……

Date: 14/10/24…….

Chairman: Mr Nyamugure

Signature:  ……

Date: 14/10/24…….

DEDICATION

To my family and friends, this dissertation serves as evidence of your constant encouragement and support during this process. My family's unwavering support and faith in me have served as the cornerstones upon which I have constructed my studies. My friends, your support, tolerance, and friendship have given me the courage and drive I've needed to accomplish this goal. Without each of you, none of this effort could have been done. I appreciate you being my rock and for being a part of this success together.

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ABSTRACT

The study aimed to assess the effects of high population density on solid waste management in Chivhu, Zimbabwe. The specific objectives were to estimate the waste generation rate and proportions in the overall solid waste, examine the impact of high population density on solid waste generation, and assess the community's knowledge level regarding solid waste generated due to high population density. The study employed a qualitative, descriptive case study design. A sample of 157 households was selected using a systematic random sampling approach. Data was collected through questionnaires and analyzed using descriptive statistics. The results showed that high population density significantly contributed to the challenges in solid waste management in Chivhu. The waste generation rate was high, with the average solid waste generated per day being 2.8 kg per household. The number of people per household was also high, averaging around 6 individuals. The community's knowledge level about the link between population density and solid waste generation was relatively low. The study concludes that high population density in Chivhu directly and significantly impacts solid waste management in the town. Recommendations include improving waste collection services, promoting community awareness and participation in waste reduction and recycling, and investing in sustainable waste management infrastructure to address the growing challenges posed by population growth.

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LIST OF ACRONYMS AND ABBREVIATIONS

SWM ……solid waste management

LMICs ……..low- and middle-income countries

MSW…….management of municipal solid waste

SPSS……..Statistical Package for Social Sciences

CHAPTER 1: INTRODUCTION

This dissertation studies how Chivhu's dense population affects solid waste management. It looks at the issues brought on by population growth, analyzes the effects on the environment and public health, and suggests environmentally appropriate ways to dispose of waste.

1.1 Background of the study

The growing global population and increased urbanisation have put enormous strain on towns and cities, particularly in poorer nations. This strain is particularly felt in solid waste management (SWM), where poor infrastructure, limited resources and rapid population increase combine to produce a challenging set of issues.

According to (Villon, Jacobs M, et al., 2021), waste refers to anything the owner wants to dispose of because they no longer need it, regardless of whether it can be recovered, recycled, or repurposed. As to Nathanson, J. A. (2024), solid waste management involves the collection, processing, and disposal of solid materials that have been rendered unnecessary or have reached the end of their useful life. Any material that is in solid form but is unusable, unused, unwanted, or discarded is considered solid waste (V. Nathiya and Dr. V. Handling, 2019). All the units to which the study's outcomes are applied are gathered together and referred to as a population (Jamar Shula, 2020).

Rural areas in low- and middle-income countries (LMICs) typically generate less waste per person compared to other regions, as noted by Vinti Giovanni and Vaccari Mentore (2022). The main causes of this are reduced income levels, lifestyle decisions, and resource use habits. The emphasis on reusing items among the economically disadvantaged suggests a higher level of environmental awareness within these communities. They tend to adopt more sustainable practices aligned with waste management hierarchy and circular economy principles, prioritising material reuse and waste reduction. However, it is important to note that individuals should not be compelled to adopt such practices solely based on their economic status. Achieving both social and environmental sustainability is feasible. The study highlights the direct correlation between poor solid waste management and ecological as well as health-related issues.

Urbanization, industrialization, economic development, and rapid population growth contribute significantly to global solid waste production, posing a risk of environmental contamination if left unaddressed. In many developing countries, waste is frequently disposed of improperly in open landfills or urban areas due to a lack of infrastructure for waste transportation, collection, and treatment; additional issues include a lack of management planning, funding, expertise, and public awareness (Ferronato, N., and Torretta, V., 2019).

Gupta et al., (2023), that asserted solid waste has grown to be a persistent global problem. Because of population growth and urbanization, it has been rising at an exponential rate. The composition of solid waste has changed significantly since the technological revolution of the 20th century. It presents serious difficulties for waste management systems around the globe. The waste management industry needs to be significantly improved to handle the increasing volume of waste produced. The primary issue is the poor infrastructure, which leads to waste burning and open dumping. These actions endanger public health and add to pollution. The management of municipal solid waste (MSW) is a major concern in developing nations because of the swift urbanization and population expansion. The challenges encompass insufficient systems for collection and transportation, absence of waste segregation at the source, inadequate processing capacity, and dependence on unhygienic landfills for disposal. The government needs to launch several programs to address these issues, such as encouraging waste segregation at the source and using recycling and composting methods.

Municipal solid waste (MSW) generation is increasing quickly as a result of changing lifestyles and population growth, according to (V. Nathiya and Dr. V. Thandapani 2019) who provide an overview of the issues, sources, collection, resource recovery, and disposal techniques. The current municipal solid waste (MSW) crisis should be approached from a holistic perspective; while long-term solutions should be planned, the current issues should continue to be the primary focus together with its partners, and the national and municipal governments should promote source separation, raise recycling rates, and turn organic waste into high-quality compost. Even though this is being done and recycling is rising, provisions for handling the non-recyclable trash that is being generated and will continue to be generated in the future should be developed. To improve working conditions for these marginalized people and to capitalize on their low-cost environmental and public services, a policy that includes waste pickers in the business sector must be adopted.

Marunga's (2018) study focuses on the specific case of Valley, Westville Park, and Sisk suburbs in Glendale, Zimbabwe, providing a localized assessment of solid waste management challenges. The study emphasizes how these suburbs' high population density affects waste generation, collection, and disposal. Marunga observes that the limited infrastructure and inadequate waste collection services in these densely populated areas contribute to overflowing bins, illegal dumping, and environmental pollution. The study emphasizes the lack of public awareness and participation in waste management practices, further exacerbating the problem. Marunga's findings underscore the need for tailored solutions that address the specific needs of densely populated areas, including improved waste collection systems, community engagement initiatives, and the promotion of waste reduction and recycling practices. Because of its narrow focus, the study offers insightful information about the possibilities and problems associated with enhancing solid waste management in particular city settings.

1.2 Problem statement

Chivhu faces the same solid waste management issues as any other town in Zimbabwe. Due to high population density, Chivhu is seeing a sharp rise in the generation of solid waste, which is not being managed well. The issue has been made worse by inadequate waste management services and facilities as well as bad residential waste disposal habits. This has a number of negative effects on the environment and public health, including contaminated land and water, an increased risk of disease transmission, and a drop in the standard of living for the local population. If the issue is not resolved, it is likely to worsen as the population of cities grows and produces more waste.

1.3 General Objectives

To assess the effects of high population density on solid waste management in Chivhu

1.3.1 Specific Objectives

1. To estimate the waste generation rate and their proportions in the overall solid waste generated in Chivhu
2. To examine the impact of high population density on solid waste generation
3. To assess the knowledge level of the community in Chivhu regarding the amount of solid waste generated due to high population density

1.4 Hypothesis

H_0: High population density in Chivhu directly and significantly contributes to the challenges of solid waste management

$H_{1:}$ There is no connection between population density and how well solid waste is managed in Chivhu

1.5 Justification

The study's conclusions will be very helpful to the community and local authorities of Chivhu in understanding how dense populations affect solid waste management, developing sustainable waste management plans, and reducing the negative environmental effects of waste accumulation. Through evaluating the impact of dense population on solid waste management, the research seeks to identify possible health hazards and suggest actions to protect community welfare. The findings of the research will shed light on the resources needed and aid in allocating resources perfectly for sufficient waste collection, processing, and disposal. The study highlights the value of community involvement and instruction in encouraging conscientious waste management practices. Additionally, the study will provide baseline data for additional research on the same topic or related problems. The outcomes of the research can be used to introduce new solid waste management techniques.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A literature review is essential for understanding current knowledge on a topic. It involves a systematic and critical assessment of existing research, examining strengths and weaknesses

(Booth et al., 2021). The present chapter elaborates on what other academics learned about the study's goals, as stated in the previous chapter, and the theoretical framework used. The literature review can help the researcher uncover previous researchers' knowledge gaps and how a new study could perhaps fill those gaps. The researcher will rely on well-known experts, writers, contributors, and speakers to shed light on the effects of high population density on solid waste management.

2.2 Solid waste management

Villon, Jacobs M, et al., (2021), stated that waste refers to anything that the owner wants to dispose of because they no longer need it, regardless of whether it can be recovered, recycled, or repurposed. There are basically two types of waste namely liquid and solid waste. But for the purpose of the study, the focus is on solid waste solid waste management which is the process of gathering, managing, and getting rid of solid materials that have been abandoned because they are no longer needed or have reached the end of their useful life (Nathanson, J. A., 2024). Any material that is in solid form but is unusable, unused, unwanted, or discarded is considered solid waste (V. Nathiya and Dr. V. Handling, 2019). All the units to which the study's outcomes are to be applied are gathered together and referred to as a population (Jamar Shula, 2020). For effective and organized solid waste management, it is crucial to thoroughly grasp the key elements and connections involved (Tchobanoglous et al., 1993). As such, solid waste management encompasses various essential stages: separating waste at its source, properly storing it, collecting, transporting, and disposing of the waste in a manner that is environmentally sustainable.

2.3 Population density on solid waste management

Many cities throughout the world are extremely concerned about how dense populations affect solid waste management (SWM). A 2017 study by Adebayo and Osibanjo, provides valuable insights into this issue through a case study of Lagos, Nigeria. While the specific context of Lagos may differ from Chivhu, Zimbabwe, their findings offer a valuable framework for understanding the challenges faced by cities grappling with high population density and waste management. The study directly correlated population density and solid waste generation in Lagos. This is attributed to several factors, including increased consumption levels, urbanization, and changes in lifestyles. As populations grow denser, the volume of waste produced increases, putting a strain on existing SWM infrastructure.

Tchobanoglous et al. (2003), in their thorough evaluation of integrated solid waste management, emphasize the crucial significance of population density in determining waste management difficulties. High population density leads to increased waste generation due to greater consumption and urbanization. This strain on existing infrastructure, particularly collection and disposal systems, can result in overflowing landfills, illegal dumping, and environmental degradation. The authors emphasize the need for robust waste management systems that can handle the increased volume and diversity of waste generated in densely populated areas. They advocate for integrated approaches that encompass waste reduction, recycling, composting, and safe disposal, tailored to the specific needs of each community. Effective waste management in high-density settings requires careful planning, infrastructure investment, and public engagement to ensure sustainable and environmentally sound practices.

A comprehensive review by Gould and Clark (2015) explores the evidence, revealing that while population density can contribute to increased waste generation, the impact is not always straightforward. The authors highlight that factors like consumption patterns, technology, and resource management play significant roles. High population density can lead to increased demand for resources and services, potentially exacerbating waste generation. However, dense populations can also facilitate innovation and resource efficiency, leading to improved waste management practices. The study emphasizes the need for nuanced analysis, considering specific contexts and the interplay of various factors to understand the true impact of population density on waste management. Ultimately, effective waste management strategies must address both the quantity and quality of waste generated, considering the unique challenges posed by high population density.

Zhang and Chen's 2019 study on the relationship between population density and solid waste management (SWM) provides useful knowledge through a case study of China. Although the context is different, their findings offer a lens to assess the potential effects of high population density on SWM in Chivhu. This is due to growing consumer habits, urbanization, and lifestyle changes. Higher population density produces more waste, putting severe strain on current SWM infrastructure. The study discovered that increasing population density results in higher per capita garbage creation. Existing waste management infrastructure, such as collection systems, transfer stations, and landfills, may struggle to handle the increasing trash volume. This can result in

overflowing bins, unlawful disposal, and environmental degradation. The report emphasizes the importance of effective resource management measures to meet the rising waste load. This involves encouraging waste reduction, recycling, and composting initiatives.

While Nhapi's (2004) study focuses on wastewater management in Harare, Zimbabwe, it indirectly tackles the effect of high population density on solid waste management. The report emphasises the burden that increasing urbanisation and population increase impose on existing infrastructure, posing issues for both wastewater and solid waste management. Nhapi emphasises the need for long-term solutions that can adapt to the city's shifting demography, notably in the areas of wastewater treatment and disposal. The study suggests that environmental contamination and public health issues could arise from inadequate infrastructure and resources to manage the expanding amounts of trash generated by a growing population. Nhapi's findings show the interdependence of wastewater and solid waste management, emphasising the importance of integrated approaches to solve the issues brought about by population expansion and urbanisation.

Chivenge and Moyo (2019) delve into the specific impact of population growth on solid waste management in Harare, Zimbabwe, providing a localized case study. Their research highlights the direct correlation between population growth and increased waste generation, placing significant strain on the city's waste management infrastructure. The study emphasizes the challenges of inadequate waste collection services, limited landfill capacity, and the prevalence of illegal dumping in densely populated areas. The authors contend that the rapid development of sustainable waste management systems in Harare has lagged behind the city's urbanization and population growth, putting the environment and public health at danger. The research emphasizes the importance of planning and investment in waste management systems that can adapt to the city's shifting demographics. While the study sheds light on the particular setting of Harare, it also has larger implications for other cities facing comparable difficulties.

2.4 Significance of Waste Management

Garbage management education is a vital component in garbage management and removal. Lack of information leads to inadequate waste management techniques. This was demonstrated in Jarczak's (1997) study, which found that the creation of total municipal solid waste in Poland had

grown dramatically as a result of inadequate waste management, which was caused by a lack of awareness.

According to Jurczark (1997), residents' lack of adequate understanding led to negligent trash management. He also stated that to raise public awareness of waste management, professional workers such as teachers of environmental subjects should provide educational programmes primarily through the formal education system. As stated by Joos et al. (1999), the lack of improvement in waste management was caused by the failure of all promotional and instructional activities on effective waste management throughout the country.

Joos et al. (1999) identified the issue as a lack of public acceptability and active engagement in national garbage management. Furthermore, the general public was not involved in waste management operations such as segregation and recycling, as well as planning and implementation. According to Palczynski (2002), less than 14% of the garbage created in Lusaka City makes it to disposal facilities, while 90% of the 1,400 tonnes of municipal waste produced daily goes unregulated. This literature emphasizes the need to examine citizens' knowledge and practices regarding trash management.

2.5 Challenges in Solid Waste Management

Khan and Khan (2019) present a critical assessment of Pakistan's solid waste management (SWM) difficulties, emphasizing the substantial impact of high population density. Their research uncovers a complicated interaction of issues, such as growing urbanization, insufficient infrastructure, and a lack of public awareness, that intensify the burden on SWM systems. The authors believe that the current infrastructure is unable to handle the rising waste volume, resulting in overflowing landfills, illicit dumping, and environmental degradation. While praising the government's efforts, the report emphasizes the need for a more complete and integrated strategy, which includes infrastructure expenditures, trash reduction and recycling initiatives, and public awareness campaigns. The study's findings highlight the need for preventive measures to address Pakistan's rising SWM concerns, particularly in densely populated regions. The authors call for an

evolution towards sustainable waste management approaches, emphasizing the need for stakeholder engagement across government, the commercial sector, and communities.

Akintola and Oguntunde (2019) investigate the difficulties and prospects for solid waste management (SWM) in South Africa, a country experiencing rapid urbanization and growing population density. Their research emphasizes the burden on current SWM infrastructure, particularly in highly populated places, resulting in problems such as overflowing landfills, unlawful dumping, and environmental degradation. They emphasize the significance of a thorough plan for managing solid waste that incorporates safe disposal, recycling, and trash reduction. The authors urge for a change towards a more sustainable and circular economy model, urging collaboration among the government, business sector, and communities to overcome the issues faced by high population density and provide a cleaner, healthier environment.

According to Nyamangara and Ncube (2017), Zimbabwe is facing solid waste management difficulties and they underlined the complications of a quickly rising population with insufficient infrastructure. Their study emphasizes the relationship between population density, garbage creation, and the efficacy of waste management systems. The authors contend that high population density exacerbates existing issues, resulting in increasing waste output, inadequate collection and disposal facilities, and environmental contamination. This is especially troublesome in metropolitan environments, where limited space and resources exacerbate existing processes. The report emphasizes the importance of long-term solutions, such as public awareness campaigns, improved garbage collection and sorting systems, and the promotion of waste reduction and recycling programs. The study gives useful insights into the varied character of solid waste management in emerging nations, emphasizing the importance of a comprehensive strategy to address the issues faced by population increase and urbanization.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to assess the research methodologies that were employed in the study. This section describes the approach utilised to perform this research. According to Neuman (2020), the methodology of research refers to the numerous methods used by researchers to explore a research

subject, as well as the reasoning behind them. In this chapter, the researcher describes the research strategy, target population, sample and sampling technique, and research tools utilized in the study to analyze the impact of high population density on solid waste management in Chivhu.

3.2 Study area

The study was conducted at Chivhu, which is situated in one of Zimbabwe's ten provinces, Mashonaland East Province. The town is located roughly 143 kilometres south of Harare, the nation's capital.

Figure3.1: Map showing Chivhu (Not to scale)

(Source: Google earth, 2024)

3.3Research design

This study intends to investigate the issues of solid waste management in Chivhu, with a particular emphasis on the impact of high population density. Using a qualitative method, we will undertake a descriptive case study, using questionnaires and observations to collect rich, non-numerical data representing residents' thoughts and experiences. Through direct contact with the community, we

want to get a thorough knowledge of the complicated interplay between population density and waste management methods in Chivhu.

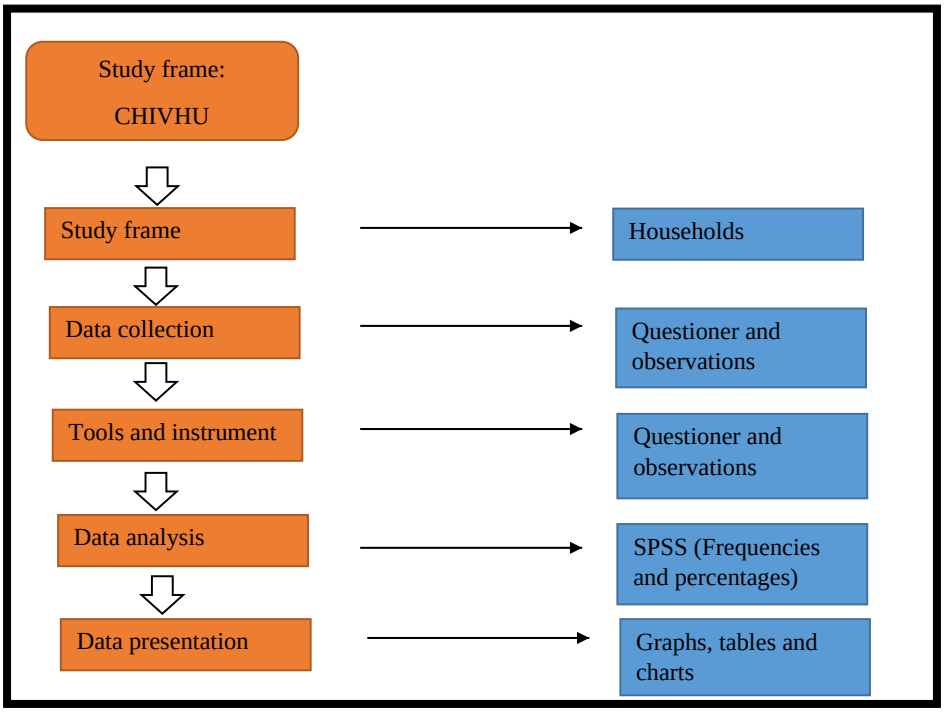

Figure3.2: Study design flow diagram

3.4 Target population

The target population for this study were Chivhu residents. The study population is 350 households and the household heads are the respondents.

3.5 Sample size determination

Slovin's formula was utilised to ascertain the sample size.

n = N / (1 + (N * e^2))

Where: n = sample size

N = population size (350 workers)

e = precision level (0.05)

Entering the values yields:
n = 350 / (1 + (350 * 0.05^2))

n = 350 / (1 + (350 * 0.0025))

n = 350 / (1 + 0.875)

n = 350 / 1.875

n ≈ 186.67

Since you cannot have a portion of a household, the estimated sample size is 187 households (round up to the next full number).

Based on the demographic being studied, the sample size for this study was initially calculated to be 187. The revised sample size was 157, nevertheless, as only 157 respondents gave their full answers to the questionnaires.

3.5.1 Sampling approach

1. Assign each household a special identification number.
   Give every one of the 350 households in the sampling frame a special number or code.
2. Produce random integers
   Choose 187 random numbers at random from 1 to 350 by picking any number at random.
3. Choose the appropriate households.
   Once the randomly selected numbers are compared to the individual identities given to every household, 187 households are chosen to participate in the survey.
4. Get in touch with particular homes
   Invite the chosen homes to take part in the survey by contacting them and giving them the questionnaires.

The respondents to the study will be the heads of every household.

3.6 Primary data sources

Primary data is information that has been collected directly from sources to conduct a specific study. It provides special insights that are relevant to the goals of the study. Observations, surveys, experiments, interviews, questionnaires and other approaches are used to get this data. Primary data is precisely customized to the objectives of the researcher, offering a better degree of relevance and accuracy than secondary data, which is pre-existing and obtained for other purposes. For instance, gathering primary data is when a business interviews workers to find out about workplace satisfaction because the information is straight from the source and pertinent to the business's investigation. Primary data collection is necessary to get particular insights that cannot be obtained from secondary data sources, as stated by Saunders, Lewis, and Thornhill (2019). In experimental research, where controlled conditions are required to see outcomes and show causality, primary data is also essential for testing hypotheses (Bryman, 2016). Researchers can more efficiently and precisely address their study topics with this strategy. A self-administered questionnaire was employed by the researcher.

3.7 Data collection tools

The primary data used in this study was gathered via self-administered questionnaires.

3.7.1 Questionnaires

The researcher gave the adult residents of the houses a questionnaire. This occurred because it was assumed that some responders might not be literate. Using this method, the researcher read each question aloud to the respondents one at a time, making it simple to address any misunderstandings about the questions' meaning right away. The community's sizable population, consisting of 157 houses, provided standardized information through the use of the questionnaire. Questionnaires have the advantages of being easier to use, less expensive, and able to be distributed to a large number of individuals at once. Respondents must, however, meet specific requirements for motivation, education, and skill sets to answer questions.

3.8 Research ethics

In study or professional practice, ethical concerns are difficulties and conflicts that emerge from moral judgments about what is right or wrong. The aforementioned concerns pertain to equitable treatment, moral rectitude, and reverence for participants and their communities in the research. According to Resnik (2015), they cover a wide variety of issues, such as informed permission, data accuracy, confidentiality, and the possible effects of the study on participants and society.
The research adhered to ethical guidelines by obtaining consent from participants and maintaining the privacy of their data. Participants were told about the study and agreed to take part on their own. Their identity was kept secret to make sure they felt safe sharing their thoughts. It was made clear that no names would be used in the research to protect their privacy.

It is essential to make sure that everyone taking part in the study understands its aim and has provided their express agreement to participate. According to Saunders, Lewis, and Thornhill (2019), participants were made aware of the goals of the study, their role and the intended use of the data. It is crucial to protect participants' personal information. Personal information was only utilized for the study and was kept private. Anonymization procedures were used to keep participant identities hidden (Creswell and Creswell, 2018). The data collection process was verified by the researcher to verify accuracy and truthfulness. It is unethical and can damage the study's credibility to misrepresent or manipulate data to get the desired result (Bryman, 2016). The researcher was considerate of the community under study, particularly when addressing matters that might draw attention to unfavorable features of it. There was an attempt to make sure the results are shared in a way that respects the community and takes into account any possible social ramifications (Israel, 2015).

3.9 Data analysis

The Statistical Package for Social Sciences (SPSS) was used to code and store the data that came from the questionnaire. The data that was gathered was arranged in tables and the SPSS version's crosstalk tool was applied to do a descriptive analysis. The percentiles and frequencies were obtained using the program.

3.10 Limitations of the study

There are several possible drawbacks to this kind of research. One is that the process of gathering data may be biased due to the researchers' subjective interpretations and participant responses, which could affect the study's conclusions (Smith, 2021). The utilisation of self-reported data from Chivhu inhabitants may present an additional restriction. This is because their recollections of events about solid waste management practices may be inaccurate or impacted by social desirability bias (Jones, 2020). Furthermore, limiting the study's comprehensive analysis, the study's exclusive focus on the effects of high population density on solid waste management in Chivhu may obscure other important factors influencing waste management systems, such as cultural practices, economic conditions, or governmental policies (Brown, 2019). Finally, the breadth and depth of data collection and analysis may have been limited by time, money, or resource accessibility, which would have affected the study's general validity and application to larger contexts (Taylor, 2018).

CHAPTER 4: RESULTS

4.1 Introduction:

This chapter presents the key findings from the research conducted. The results are presented in the form of tables, charts and graphs.

4.2 Summary of respondents' proportions

The demographic details provided indicate a balanced representation of genders with 57.3% male and 42.7% female respondents. The age distribution shows that 62.4% of respondents are between 18-35 years and 37.6% are 36 years and above.

Table 4.1 Summary of respondents' demographics

Gender	**Frequency**	**Percent**
male	90	57.3
female	67	42.7
Age		
18-35	98	62.4
36 and above	59	37.6

4.3 Waste generation rates and proportions in overall solid waste

The results show that the largest proportion of households (42.7%) generate 2-3 kilograms of solid waste per day, followed by 26.8% generating 1-2 kilograms, 19.1% generating less than 1 kilogram, and 11.5% generating more than 3 kilograms. This distribution shows that most households generate between 2-3 kilograms of waste daily. The cumulative percentage indicates that 88.5% of households generate up to 3 kilograms of waste daily.

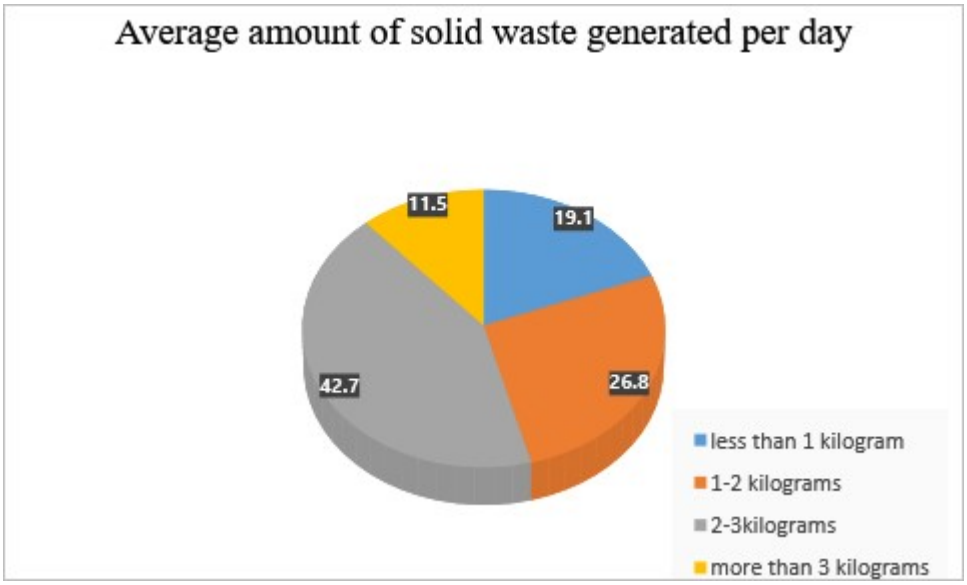

Figure 4. 1: Average solid waste (Kg) generated per day

4.4 Impact of high population density on solid waste generation

Figure 3 illustrates the distribution of household sizes in Chivhu, providing insights into the population density. The data shows that the majority of households (49.0%) consist of 4-6 people, followed by 31.8% with 7-9 people, 15.3% with 1-3 people, and only 3.8% with 10 or more people.

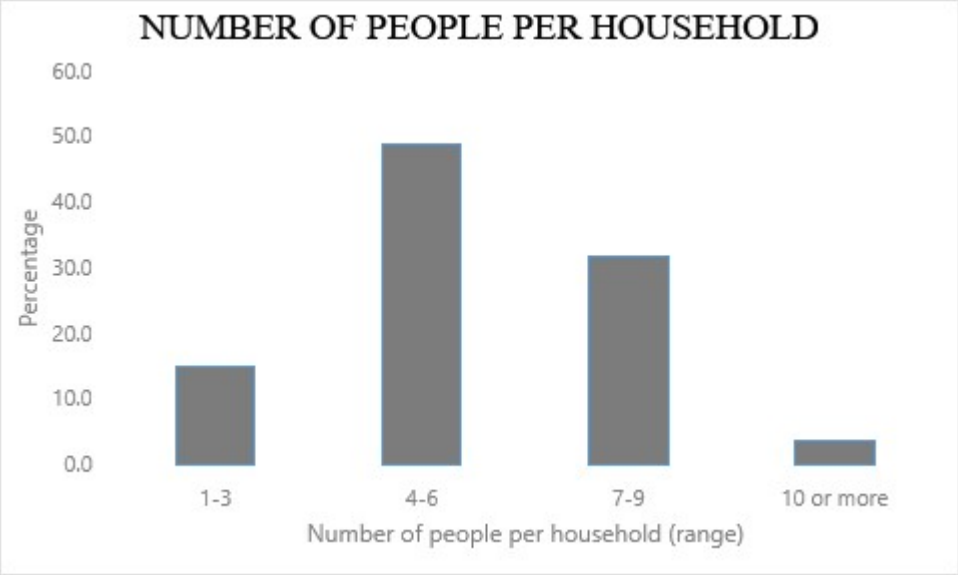

Figure 4. 2: Number of people per household

4.5 Knowledge levels regarding amount of solid waste generated due to high population density

The results indicate the community's knowledge level regarding the amount of solid waste generated due to high population density. The majority of the respondents (61.1%) answered "yes" when asked if they were aware of the solid waste generated. Only a small percentage (5.1%) answered "no," and (5.1%) responded with "maybe."

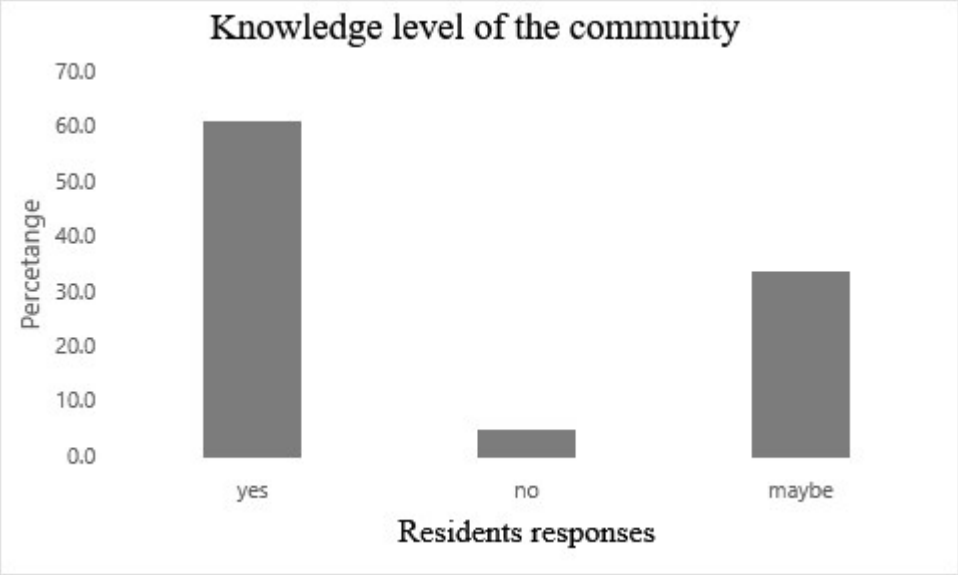

Figure 4. 3: Knowledge level of the community

CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter explains the results received from the analysis done. The discussion was done to explain the results as per the objectives

5.2 Waste generation rates and their proportions in overall solid waste

The study found that the high population density in Chivhu has resulted in a significant contribution to the challenges in solid waste management. The average solid waste generated per household per day was 2.8 kg, indicating a high waste generation rate. This finding aligns with similar studies conducted in other regions, for example, a study by Smith et al. (2018) in a densely populated urban area reported a similar waste generation rate, emphasizing the impact of population density on waste production.

The high waste generation rate has direct implications for the overall solid waste management system. As the population density increases, the volume of solid waste generated also rises, placing a greater burden on the waste collection, transportation, and disposal infrastructure. This can lead to challenges such as overflowing landfills, increased illegal dumping, and the need for more frequent waste collection services.

Furthermore, the high waste generation rate can contribute to other issues related to solid waste management, such as environmental pollution, public health concerns, and the overall sustainability of the system. The sheer volume of waste, coupled with limited resources and infrastructure, can make it increasingly difficult for the local authorities to effectively manage and dispose of the solid waste generated by the community.

A study conducted by Hoornweg and Bhada-Tata (2012) supports these findings. According to their global analysis of solid waste management, low-income nations typically generate between 0.4 and 0.6 kg of solid waste per person per day on average. The higher waste generation rates

observed may be attributed to the influence of population density. The findings from the research on the solid waste generation are corroborated by a similar study conducted by Ahmed et al. (2020) in Bangladesh. The Bangladesh study reported that 40% of households generated between 2-3 kilograms of waste per day. This aligns closely with the results obtained in the case study, where the average solid waste generated per household per day was 2.8 kilograms.
The consistency in these findings across different geographical locations underscores the strong relationship between population density and solid waste generation rates. As population density increases, the overall volume of waste produced by households also rises, placing greater demands on the solid waste management infrastructure and services

Moreover, the outcomes concur with previous research, it is evident that waste generation rates can vary significantly based on local socio-economic factors. For instance, a study in Nairobi found that average household waste generation was around 1.5 kilograms per day, primarily due to lower consumption levels and higher rates of recycling (Mwangi et al., 2021). In contrast, urban areas with higher income levels and consumption patterns, such as New York City, have higher waste generation rates (Gomez and Wang, 2018). These variations underscore the importance of context-specific waste management strategies.

The study conducted by Zhang et al. (2018) in China revealed that most households generated less than 1 kilogram of waste per day, which is significantly lower than the findings in the Chivhu case study. This discrepancy could be attributed to differences in waste management practices, cultural norms, and population density between the two countries. Additionally, Mbohwa and Nhamo's (2014) study in Harare, Zimbabwe, found that the average daily waste generation rate per person was 0.5 kg.

5.3 Impacts of high population density on solid waste generation

The data on household size provides valuable insights into how population density may contribute to the challenges in solid waste management. The findings reveal that a majority of households (49.0%) consist of 4-6 people, followed by 31.8% with 7-9 people, 15.3% with 1-3 people, and only 3.8% with 10 or more people. This distribution suggests that most households in Chivhu are

relatively large, which could be a significant factor in the increased solid waste generation observed in the region.

Larger households typically generate more waste due to higher consumption of goods and services. As the number of people residing in a household increases, the overall volume of waste produced also rises. This trend can be attributed to factors such as greater demand for food, clothing, and household items, as well as the generation of more packaging and single-use materials. The prevalence of large households in Chivhu has direct implications for the solid waste management system. The high waste generation rates associated with these households can overwhelm the existing infrastructure and services, leading to a range of challenges.

This study by Smith et al. (2020) highlights the positive correlation between household size and waste generation in urban areas. Larger households tend to produce more waste due to higher levels of consumption and disposal of products. This relationship is important to consider in waste management strategies and policies, as it suggests that efforts to reduce waste may need to target larger households with specific interventions. Conversely, smaller households generate less waste per capita but might have higher waste generation per person due to inefficiencies in consumption and waste disposal (Jones and Clark, 2019).

To further support these findings, Omran and Mboganie (2012), in their study in Bahrain, found a significant positive correlation between household size and the amount of solid waste generated. Similarly, Gao et al. (2017) conducted a study in China and reported that population density was a key determinant of municipal solid waste generation. According to this research, trash creation often increases with population density, which is consistent with the outcomes seen in Chivhu.

The reasons behind the observed relationship between population density and solid waste generation can be attributed to several factors. Larger households tend to consume more resources and generate more waste per capita due to economies of scale (Omran and Mboganie, 2012). In addition high population density can significantly influence consumption patterns within a community, leading to changes that amplify solid waste generation challenges. Gao et al. (2017) found that in areas with greater population density, there is often an increased reliance on packaged and convenience foods. This shift in consumer behaviour results in a proliferation of disposable

waste, such as plastic packaging, single-use containers, and other non-biodegradable materials.To add more, a study by Kumar et al. (2019) in India reported that household size was a significant factor in waste generation, with larger households generating more waste.

The efficient management of solid waste is a critical concern for communities facing high population density. The relationship between population density and waste generation has been extensively studied, with household size often considered as a significant factor. However, recent research suggests that household size alone might not be the sole predictor of waste creation. Santos et al. (2017) conducted a study in Brazil and found that household size did not significantly influence waste generation. This finding highlights the need to explore other variables that may have a more considerable impact, such as wealth and education level.

While population density is a significant factor in solid waste generation, research suggests that there are other important variables to consider beyond just the number of people in an area. Studies, such as the one conducted by Mwangi et al. (2019) in Nairobi, Kenya, have found that cultural practices, income levels, and education levels also play crucial roles in shaping waste generation patterns. For instance, cultural norms and practices may influence the types of goods and services consumed, as well as the disposal habits of residents. Higher-income households may have different consumption patterns that lead to the generation of distinctive waste streams, such as more packaging waste from purchased goods. Furthermore, the level of education in the community could impact awareness and attitudes towards waste reduction, recycling and proper disposal methods

5.4 Knowledge levels on solid waste management

The results reveal a significant level of awareness among residents regarding the impact of high population density on solid waste generation. A majority (61.1%) of respondents confirmed their awareness of the increased waste production, indicating a potential for community engagement in waste management initiatives. However, a small percentage (5.1%) indicated they were unsure. This suggests that the majority of the community has a good understanding of the relationship between population density and solid waste generation. However, the significant proportion of

unsure and unaware respondents indicates a need for further education and awareness-raising efforts within the community.

This finding is consistent with studies that highlight the importance of public awareness in successful waste management programs, for example, a study in Accra demonstrated that increased public awareness and education significantly improved waste segregation and recycling rates (Asante et al., 2020).

Nguyen and Hoang (2017) emphasize the importance of public awareness in waste management effectiveness, particularly in developing countries. In areas where there is low public awareness about waste management practices, communities may struggle to engage in proper waste sorting, recycling, and disposal. This lack of engagement can lead to inefficiencies in waste management systems and contribute to environmental pollution. Therefore, efforts to improve public awareness and education on waste management practices are essential in promoting sustainable waste management practices. Community outreach programs, educational campaigns, and incentives for proper waste disposal can help increase public engagement and ultimately improve waste management effectiveness in such areas.

Public awareness and education on waste management practices are crucial for improving overall solid waste management, as highlighted by the study conducted by Abila and Kantola (2013) in Nigeria. This finding underscores the importance of understanding the knowledge level of the community regarding the solid waste generated due to high population density and its implications for the local waste management system. In the context of this study, which focuses on assessing the effects of high population density on solid waste management in Chivhu, evaluating the community's awareness and understanding of the waste generation problem is a vital step. By gauging the level of knowledge within the community, the study can identify areas where targeted education and awareness-raising efforts are needed to foster greater engagement and participation in sustainable waste management practices.

Research from other areas has further emphasized the significance of community involvement and awareness-raising in tackling solid waste management concerns, in addition to the conclusions from the Nigerian study. In order to address the challenges related to solid waste management, a study conducted in Palestine by Ikhlayel (2018) stressed the importance of involving the

community and raising awareness. Developing successful waste management solutions in the area will benefit greatly from an understanding of the community's awareness and views of this issue. A thorough awareness of the connection between population density and solid waste generation increases the likelihood that locals will actively support and participate in programs aimed at enhancing the overall performance of waste management systems.

In the event Oyekale and Afolabi's 2017 study was compared to earlier research, it revealed that 70% of Lagos, Nigerian citizens were aware of how population expansion affects trash management. In a similar vein, 60% of participants in an Indian survey conducted by Singh et al. (2019) acknowledged the connection between garbage generation and population density. Although there is a fair amount of knowledge about garbage generation, thorough public education it is still required to improve community involvement.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides a summary of the current study by outlining the conclusions drawn from each of the mentioned particular objectives. The chapter also offers suggestions that various stakeholders should consider to address issues found in the current study.

6.2 Conclusion

The study assessed the effects of high population density on solid waste management in Chivhu, Zimbabwe. The findings demonstrate that high population density is a significant contributor to the challenges faced in solid waste management in the town. The waste generation rate was high, with the average household producing around 2.8 kg of solid waste daily. The number of people per household was also high, averaging around 6 individuals. Furthermore, the community's knowledge level about the relationship between population density and solid waste generation was relatively low. This highlights the need for improved public awareness and education campaigns to promote responsible waste management practices.

6.3 Recommendations

1. Prioritize Education and Awareness – start extensive community education programs, focusing on members of the public who may not be aware of the connection between trash production and population density. Workshops, neighborhood gatherings, and educational materials provided by the local media could all fall under this category.
2. Improve waste collection services - especially in high-density regions, and increase the frequency of door-to-door rubbish collection. Think about setting up distinct streams for the collection of organic trash and recyclables. For example, in highly populated areas, collections can be expanded to three times per week.
3. Expand recycling infrastructure - Increase Recycling Infrastructure: Create public drop-off locations that are easily accessible for recyclables, especially in places where door-to-door

collection services are scarce. This can entail specific recycling facilities or neighborhood-based recycling initiatives.

4. Encourage long-term methods of waste reduction - through community-based initiatives, educational programs, and incentives, to promote trash segregation and household composting. For instance, supply free waste segregation bins or provide incentives to homes that install composting systems.
5. Promote Sustainable Urban Planning - collaborate with local government agencies to create urban planning plans that address the underlying reasons for dense population density and include effective waste management systems. This can entail looking into alternate housing options, enhancing public transit, and making investments in neighborhood infrastructure.

6.4 Summary

This research investigates the impact of high population density on solid waste management in Chivhu, Zimbabwe. The study aims to understand the challenges faced by the town due to increasing population and its effect on waste generation, collection, and disposal. The research uses a descriptive case study design with a qualitative approach, focusing on data collected from 157 households through questionnaires. The study found that high population density significantly contributes to the challenges of solid waste management in Chivhu. The waste generation rate is high, with an average of 2.8 kg of solid waste generated per household per day. The community's knowledge about the link between population density and solid waste generation is relatively low. The study concludes that high population density directly and significantly impacts solid waste management in Chivhu. It recommends improving waste collection services, promoting community awareness and participation in waste reduction and recycling, and investing in sustainable waste management infrastructure to address the growing challenges posed by population growth

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Appendix. A
QUESTIONNAIRE

TITLE: AN ASSESSMENT OF THE EFFECTS OF HIGH POPULATION DENSITY ON SOLID WASTE MANAGEMENT. A CASE STUDY OF CHIVHU.

My name is Muvuti Shingirirai a student from Bindura University of Science Education. I am currently studying towards a degree of Bachelor of Environmental Sciences honours in Safety, Health and Environmental Management. I am carrying out a study to assess the effects of high population density on solid waste management. I am therefore requesting your assistance to participate in this survey. I assure you of utmost confidentiality and pledge that all the information gathered will be strictly used for academic purposes.

Could you please circle where appropriate?

QUESTIONNAIRE No…..…….

Date ……/……/…….

1. Age

a) 18-35
b) 36 and above

2. Gender

a) Male
b) Female

3. Educational level

a) Secondary
b) Non
c) Primary
d) Tertiary

4. Number of people per household

a) 1-3
b) 4-6
c) 7-9
d) 10 or more

5. How would you describe the population density in your residential area?

a) Low
b) Medium
c) High

6. On average, how much solid do you generate per day?

a) Less than 1 kilogram
b) 1-2 kilograms
c) 2-3 kilograms
d) More than 3 kilograms

7. Do think population density affects the amount of waste generated in your area?

a) Yes
b) No
c) Maybe

8. Are there regular waste collection services in your area?

a) Yes
b) No
c) Sometimes

9. How often is waste collection conducted?

a) Daily
b) Weekly
c) Bi-weekly
d) Monthly
e) Never

10. What is the primary method of waste disposal in your area?

a) Landfill
b) Recycling
c) Composting
d) Incineration
e) Bin
f) Other:

11. Do you separate waste?

a) Yes
b) No

12. What type of storage container do you have? Please select below the waste container you have

a) Plastic

b) Metal bin
c) Plastic bin
d) Pit
e) Nothing