



Solid waste management and its impact on quality of life: Case study of the Torone Velho neighborhood, Quelimane, Mozambique during the period of 2018 to 2021

Gestão de resíduos sólidos e seu impacto na qualidade de vida: Caso de estudo do bairro Torone Velho, Quelimane, Moçambique durante o período de 2018 a 2021

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ABSTRACT

The theme addressed is solid waste management and its impact on the quality of life of the population in Torrone Velho neighborhood, in the municipality of Quelimane city, during the period from 2018 to 2021. The study was conducted with the aim of analyzing the situation of solid waste management in the neighborhood and its impact on the quality of life of the population, through inter-views, questionnaires, and observations. The results indicated the lack of adequate infrastructure for solid waste management, resulting in the accumulation of garbage in streets and public areas, com-promising public health and the environment. Additionally, the lack of environmental education and awareness on the part of the population was also identified as one of the main factors contributing to the problem. As a conclusion, it is necessary to implement public policies aimed at improving sol-id waste management and promoting environmental education among the population, in order to improve the quality of life in the neighborhood. The study methodology used in this research was a qualitative approach, based on semi-structured interviews and field observations. The research was carried out in Torrone Velho neighborhood, located in the municipality of Quelimane city. To de-fine the sample size, Yamane's formula (1970). The calculation resulted in a minimum sample of 98 individuals. However, to increase the precision of the results, it was decided to increase the sample to 100 individuals.

Keywords: Waste management, Solid waste, Quality of life.

1 INTRODUCTION

Solid waste management is a process that involves various activities and actions to properly manage solid waste generated by a community or society. For Jacobi and Besen (2011), the process includes the collection, transportation, treatment and final disposal of waste in a safe and efficient manner, with the aim of avoiding negative impacts on public health and the environment. It is important to note that solid waste management can also include waste reduction and recycling activities with the aim of minimizing the amount of waste generated and maximizing the use of resources (Das et al., 2019).



Solid waste management is a fundamental process to avoid negative impacts on public health and the environment and improper waste management can lead to air, water and soil contamination, as well as the spread of diseases and the generation of bad odors and discomfort for the population. In addition, solid waste management is an important part of environmental management and sustainable development as it helps to minimize the negative impacts of human activity on the environment and public health (Burns et al., 2021).

Proper solid waste management is essential to avoid negative impacts on public health and the environment, as well as to promote sustainable development and the circular economy. In this sense, solid waste management is an important part of the global sustainable development agenda, established by the United Nations (UN) through the Sustainable Development Goals (SDGs). The SDGs are a set of 17 Goals and 169 targets that seek to guide countries towards a more sustainable, equitable and just future for all (Castel-lani et al., 2022).

According to De Benedicto et al. (2023), the proper management of solid waste is essential for the achievement of several SDGs, such as health and well-being, clean water and sanitation, sustainable cities and communities, responsible production and consumption, and climate action.

According to Guerrero et al. (2013), it is critical that appropriate solid waste management policies and practices are implemented worldwide in order to ensure a more sustainable future for all.

In Africa, proper solid waste management is essential for sustainable development and is an integral part of the Africa Agenda 2063. This initiative aims to guide African countries towards a more prosperous, inclusive and sustainable future through a set of strategic objectives that address key challenges facing the continent (Owusu-Ansah et al., 2022).

Kanhai et al. (2021) comment that to achieve adequate solid waste management in Africa, it is necessary to implement policies and practices that address the continent's specific challenges, such as the lack of adequate infrastructure and the lack of financial and technical resources. Furthermore, it is important to involve local communities in the solid waste management process, to encourage participation and shared responsibility in building a more sustainable future for Africa.

Mozambique, like many other African countries, faces significant challenges in solid waste management. Lack of adequate infrastructure, financial and technical



resources, as well as low awareness among the population, have contributed to a situation of solid waste accumulation in many cities and urban areas of the country. The situation is particularly critical in peri-urban areas, where solid waste management is often non-existent and waste is burned or dumped in open dumps, which can have negative impacts on public health and the environment (Villa et al., 2022).

In this context, the present study aims to analyze the impact of solid waste management on the quality of life of the population of Bairro Torrone Velho, located in the Municipality of Quelimane City in Mozambique, in the period from 2018 to 2021. From the analysis of the data collected, it was possible to identify the main problems related to solid waste management in the neighborhood and propose solutions to improve the quality of life of the local population.

The problem of inadequate solid waste management has been a growing concern in recent years in this research region. The impacts on public health, the environment and the quality of life of the population were examined, and existing government initiatives and policies for improving solid waste management in the neighborhood were evaluated. The results of this study can provide important subsidies to improve solid waste management in Bairro Torrone Velho and other similar communities, contributing to the improvement of the quality of life of the population and the preservation of the environment.

2 OBJECTIVE

To analyze solid waste management in this specific neighborhood and assess its impact on the quality of life of the local population over a three-year period from 2018 to 2021.

3 METHODOLOGY

The implementation of this work followed a set of research methods and techniques that allowed the achievement of the proposed objectives.

The methodology used in this research was a qualitative approach based on semi-structured interviews and field observations and quantitative through statistical analysis

Interviews were conducted with residents of the neighborhood on solid waste management from collection and final disposal of solid waste. Direct observation of solid waste collection and storage conditions in the neighborhood was also conducted.



The analysis of the collected data was carried out using the content analysis technique, which consists of categorizing and organizing the data into themes and sub-themes relevant to the study. Based on these themes and sub-themes, descriptive and interpretive analyses were carried out in order to identify the main issues related to solid waste management and its impact on the quality of life of the population of Bairro Torrone Velho.

The population universe of this study is composed of the residents of the Old Torrone neighborhood, 2,136 men and 2309 women for a total of 4,445 inhabitants, INE (2017), who are directly or indirectly affected by solid waste management in the region.

The sample of the present study was composed of 100 residents of the Torrone Velho neighborhood, randomly selected. To define the sample size, the formula proposed by Yamane (1970) was used.

$$n = \frac{N}{1 + Ne^2}$$

Where: n = amostra, N = número de população e e = Margem de erro.

For the case under study, the population being finite and considering a confidence level of 95% and a margin of error of 10%, i.e., $N = 4445$ e $e = 10\% \Rightarrow e = 0,1$ we have:

$$n = \frac{4445}{1 + 4445 \times 0,1^2} = 97,7998 \Rightarrow n \cong 98$$

The calculation resulted in a minimum sample of 98 individuals. However, to increase the precision of the results, it was decided to increase the sample to 100 individuals.

According to Oliveira et al. (2017), the choice of the population universe is important to ensure the representativeness of the results, since the sample must be a reflection of the universe studied.

The data obtained were analyzed using descriptive statistics, using graphs to present the results. Qualitative analyses of the data were carried out, where the main



problems related to solid waste management in the neighborhood and the possible solutions to these problems were identified.

4 SOLID WASTE MANAGEMENT

Solid waste management is an important issue for the quality of life of the population and for the protection of the environment. In the context of Bairro Torrone Velho, in the municipality of Quelimane City, Mozambique, inadequate solid waste management has affected the quality of life of residents and generated negative impacts on public health and the environment.

To address this problem, it is essential to adopt proper solid waste management, which includes the collection, transportation, treatment and final disposal of waste in a safe and sustainable manner. In addition, it is important to involve the community in waste management by promoting environmental education and awareness on the importance of waste segregation and recycling.

The implementation of public policies aimed at solid waste management, combined with the active participation of the community, can contribute to improving the quality of life of the population in Bairro Torrone Velho and other places affected by inadequate solid waste management.

Another important milestone for solid waste management is the Decree Law No. 13 /2006 of June 15, approving the Regulation on Solid Waste Management [...], which states that the Municipal Council (Public Power) is the one who should think about the strategy for Urban Solid Waste Management, is the center of all the demands of this sector, it establishes principles, objectives and instruments for the integrated management of solid waste, as well as the promotion and protection of public health and the environment.

In the context of Bairro Torrone Velho in the Municipality of Quelimane City, the issue of solid waste management is a constant challenge that directly affects the quality of life of the population. The lack of infrastructure and resources for collection, transportation, proper treatment and final disposal of solid waste results in accumulation of garbage in public spaces, streets and even in homes, increasing the risk of disease and negatively affecting the environment (Sambo, 2018).

In the specific context of the Municipality of Quelimane, there are local solid waste management initiatives, such as collection by a Municipal Sanitation Company (EMUSA). In addition, the Municipality already has space for the construction of a



sanitary landfill and the realization of educational campaigns to raise awareness among the population about the importance of depositing waste in appropriate places.

However, despite these initiatives, there are still challenges in solid waste management in Que-limane, such as the lack of adequate infrastructure, insufficient financial and human resources and the need for greater involvement of the local community.

Given this context, it is essential that solid waste management policies and practices are implemented that take into account local characteristics and the needs of the population, thus ensuring the protection of the environment and improving the quality of life of the population.

Proper solid waste management is a topic of great importance for the quality of life of the population, especially in urban areas. According to Biderman and Bezerra (2016), poor solid waste management can cause several negative impacts, such as soil, water and air contamination, as well as public health problems and visual degradation of the urban environment. Therefore, it is essential to create and promote an adequate solid waste management policy to protect the environment and the health of the population.

In the specific case of Bairro Torrone Velho, in the Municipality of Quelimane City, solid waste management presents particular challenges, as highlighted by Gahagan et al. (2019), urban areas in developing countries often face limitations in infrastructure and institutional capacity for proper solid waste management. In addition, the lack of awareness among the population about the importance of solid waste management can also hinder the process.

The thinking of authors such as Sambo (2018) and Gahagan et al. (2019), is echoed by other authors such as Munguambe et al. (2021) who point to the lack of adequate infrastructure as the cause of inefficiency in the collection and inadequate disposal of solid waste that has a negative impact on the quality of life of the population. To solve these problems, a joint effort by governments, civil society and the private sector is needed to ensure proper and sustainable solid waste management.

Thus, it is essential that solid waste management policies and strategies are implemented that take into account the particularities of the Torrone Velho neighborhood and the needs of the local population. As highlighted by Silva et al. (2017), it is important to involve the population in the participatory management of solid waste, promoting awareness about the importance of correct waste separation and encouraging participation



in recycling and reuse initiatives. In addition, investments in infrastructure and technical training are necessary to ensure proper solid waste management.

In addition to the barriers pointed out by other authors Gahagan et al. (2019) and Munguambe et al. (2021), inadequate solid waste management can lead to soil and water contamination in addition to attracting other disease vectors such as flies and rats, increasing the risk of infectious diseases in the population (Costa et al., 2019).

Hence, Ferreira et al. (2017) state that the lack of regular collection and inadequate deposit of solid waste can cause public health problems, such as the proliferation of disease vectors, bad smell and air and soil pollution. In addition, the presence of garbage in the streets can generate an unpleasant and unsafe environment for the population.

Inadequate solid waste management can have serious consequences for the health of the population, including the spread of infectious diseases and contamination of soil and water. A study conducted in Uganda showed that inadequate solid waste management was associated with a significant increase in acute diarrheal and respiratory diseases in the local population (Nabulo et al., 2014).

Both Costa et al., (2019) and Nabulo et al., (2014) agree that inappropriate solid waste management can have serious consequences for the health of the population, including the spread of infectious diseases. Inadequate solid waste management has direct consequences on the quality of life of the population, including impacts on health, the environment and the local economy.

In this research, the factors identified about waste management in the Bairro do Torrone Velho are the same as those shared by Sambo (2018), Gahagan et al. (2019) and Munguambe et al. (2021) who point out the lack of adequate infrastructure for sanitation of the environment or solid waste management, and the others Nabulo et al.(2014), Ferreira et al. (2017), and Costa et al., (2019) portray the inadequate management of solid waste and the spread of infectious diseases, so it is noted that the first factor impacts the second or the second becomes a dependent variable of lack of adequate and efficient infrastructure.

To deal with these challenges, it is necessary to adopt an adequate solid waste management. According to the Brazilian Association of Public Cleaning and Special Waste Companies, ABRELPE (2021), solid waste management involves actions of collection, transportation, treatment and final disposal of waste generated by the population. It is important to emphasize that solid waste management must be carried out



in an integrated and sustainable manner, considering the environmental, social and economic aspects involved.

In the specific case of the study area, inadequate solid waste management may be contributing to public health problems and environmental degradation.

To improve solid waste management in the Neighborhood and ensure a better quality of life for the population, it is necessary to implement effective public policies and involve the local community in the process. Actions such as selective collection, composting and environmental education can contribute to reduce the amount of waste generated and promote a culture of sustainability among residents.

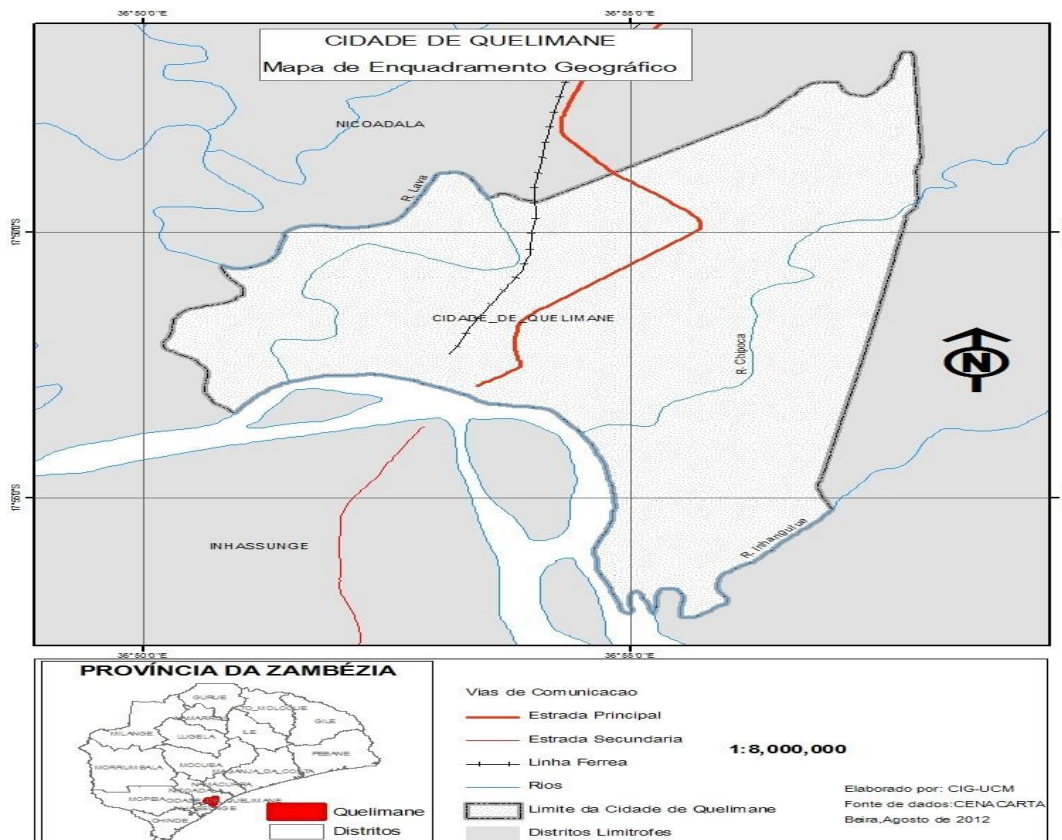
Given this context, it is essential that effective measures be implemented to improve solid waste management in the neighborhood in order to ensure a healthy environment and better quality of life for the population. These measures should include actions to sensitize the population on the importance of selective collection, recycling and proper waste disposal, as well as investments in infrastructure and staff training for proper solid waste management (Komakech et al., 2020).

On the other hand, it is crucial that local authorities and the general population are aware of the risks associated with the accumulation of waste in public areas and residential spaces. Community participation in solid waste management is also crucial to ensure the effectiveness of the process.

5 DATA ANALYSIS AND INTERPRETATION

The research was conducted in Bairro do Torrone Velho, in the Municipality of Quelimane City, Mozambique, between parallels $17^{\circ} 47' - 17^{\circ} 57' S$ and $36^{\circ} 50' - 36^{\circ} 57' E$, on the north bank of the Bons Sinais River, about 20 km from the Indian Ocean coast and at an altitude not exceeding 100 meters above mean sea level.

Figure 1: Geographical framework map of Quelimane.



Source : CENARTA, (2012). Adapted by the author, 2023.

In the present research, the use of the questionnaire technique was addressed, which was implemented in the form of a survey of the residents of the neighborhood under study.

To define the sample size, the formula proposed by Yamane (1970) was used, The calculation resulted in a minimum sample of 98 individuals and for greater precision it was increased to 100.

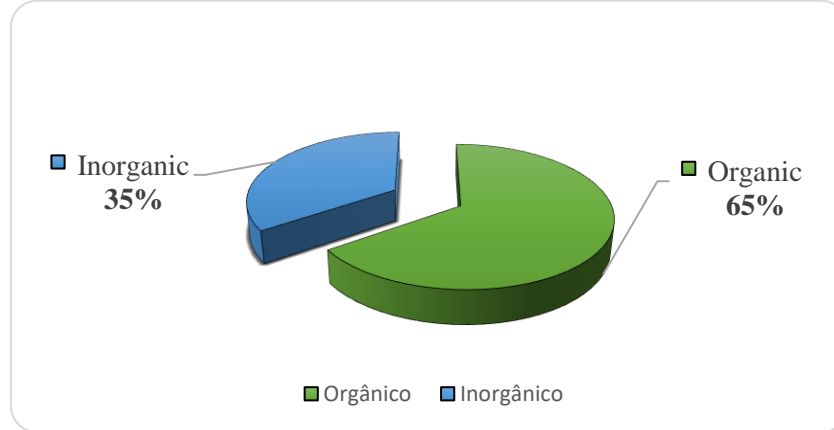
This analysis and interpretation of the data is subdivided into two (2) parts namely: characterization of the management of household solid waste by residents (the packaging); Analysis of the Action of the solid waste management system of the Municipal Council in the Torrone Neighborhood.

5.1 CHARACTERIZATION OF HOUSEHOLD SOLID WASTE MANAGEMENT BY RESIDENTS: PACKAGING

To begin with, we sought to know about the type of solid domestic waste produced in the neighborhood, regarding its chemical composition. The following result was obtained, presented in graph 1.



Chart 1: TYPES OF HOUSEHOLD SOLID WASTE IN TERMS OF COMPOSITION



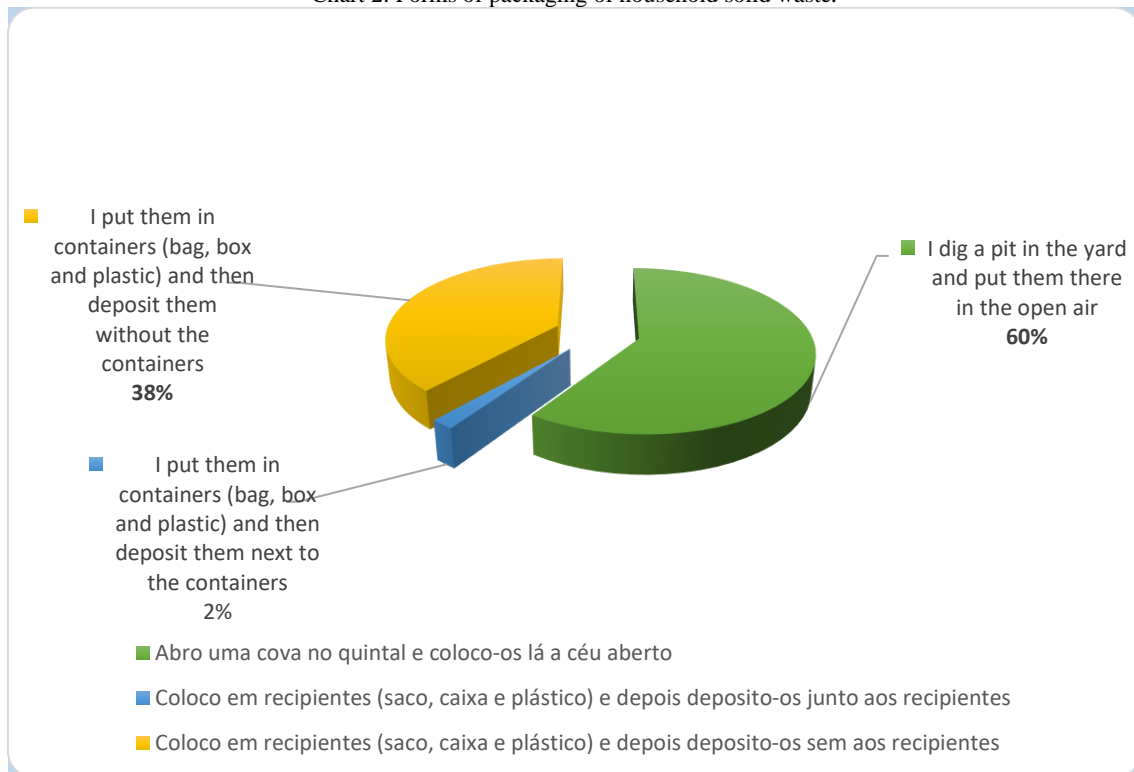
Source: Author, (2023)

It was found that in this neighborhood it produces more organic solid waste such as vegetable and animal remains, leftover meals, leftover ingredients (potato peels, onions, among others), papers, among others, because about 65% of respondents said so. However, it is noted that it also produces a considerable amount of inorganic solid waste such as synthetic material (plastics, synthetic fibers, bags); metallic materials (iron, zinc, etc.) and technological materials (remains of stereos, remains of cell phones, remains of lamps, etc.), as about 35% of respondents said so.

It is clear that this neighborhood produces inorganic solid waste that when poorly managed alters the natural conditions of the environment, which can compromise the physical and chemical conditions of some natural resources (with particular emphasis on the soil). As well as organic solid waste when poorly managed promote the proliferation of disease vectors, thus compromising the public health of the local population.

To try to understand the extent to which this solid waste constitutes a danger to the environment and public health, we sought to understand how the waste is packaged by the residents, and the following results were obtained, presented in Graph 2.

Chart 2: Forms of packaging of household solid waste.



Source: Author, (2023)

It was clear that many residents hardly pack the solid waste produced in their homes, as most of them, about 60%, reported that they only open a pit in their yard and put the waste in the open, thus increasing the risks to the environment and public health. Similarly, it was found that the few who pack solid waste do so by placing it in containers such as bags, boxes and black plastics, tying them to avoid bad odors. However, most of them, about 38%, put this solid waste there to later dump it in the garbage containers and return with the containers to the house. Only 2% throw and/or deposit the wrapped solid waste in the containers.

It is noted that the lack of adequate packaging of solid waste is quite serious, because the way it is done in the study area, contributes to the triggering of environmental degradation and negatively influences public health.

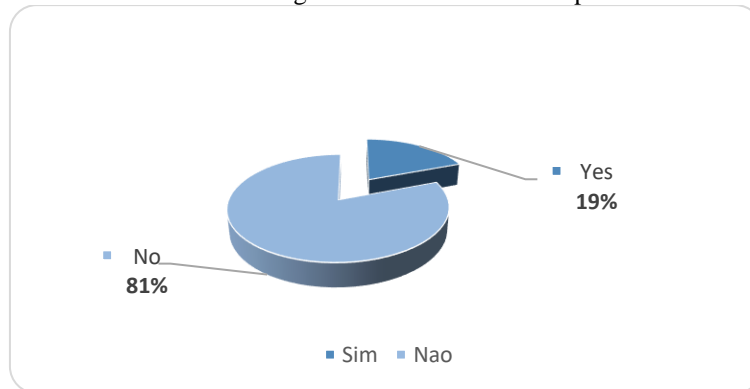
The fact that the waste is dumped in the municipality's garbage dumps (containers) without containers, contributes to problems in the period of its transportation, such as ease of these falling when being transported, in addition, it has greater ease of decomposition and proliferation of bad smell in the road (when transported outside the containers, because we do not have solid waste compactor cars).

Again, in order to understand how impactful the solid waste disposal activities carried out by the residents are, it was sought to know whether before burying, burning



and depositing in the municipal dumps or containers, whether the residents do the selection of these. And the following result was obtained presented in graph 3.

Chart 3: Sorting of solid waste before disposal.



Source: Author, (2023)

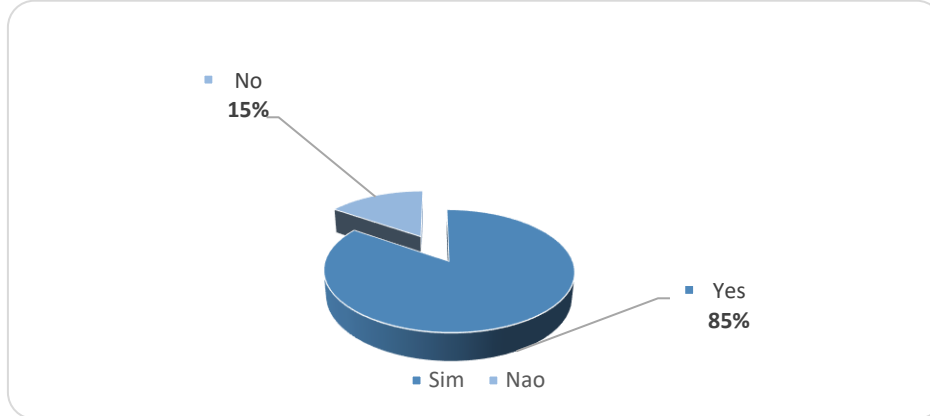
It was clearly noted that most residents do not select solid waste before disposing of it or depositing it in places to be collected by the municipality, as 81% said so. Only 19% said they do sort before disposal, noting that those who said so are those who burn solid waste.

This fact is serious, because not all solid waste is suitable to be buried, for this reason it can be said that the soil in this neighborhood is damaged, so many when having to open a grave, find shards of glass, plastics, buried zincs, elements that also constitute a danger to public health, because they are sharp.

As it was found that many residents do not deposit their solid waste in places indicated by the municipal council, so that without being collected by the solid waste management system of the municipality, it was sought to know if the residents know the pre-established places for the deposit of solid waste in this neighborhood, and the following result was obtained presented in graph 4.

Looking at the graph below, it was clearly understood that most residents know the places indicated by the municipal council for the deposit of solid waste, since about 85% said so. And only 15% of residents said they did not know these locations.

Chart 4: Knowledge of the sites indicated by the city council for depositing household solid waste.

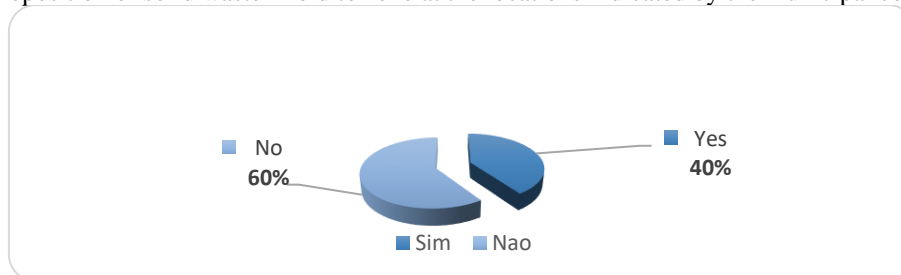


Source: Author, (2023)

From the results discussed above, it is not understood why most residents prefer to deposit or dispose of solid waste themselves in ways that are not appropriate, time and again they complain about paying the garbage fee, if they know where they should put the garbage for the municipality to collect, why don't they do it? To this question, practically all of them said that the points are far from most of the residents, a few said that they do not see the need to dispose of them if they can dispose of them themselves. In short, the reasons listed should not be used as an excuse, it clearly illustrates that most residents are not environmentally aware of their actions.

To further explore the issue of depositing solid waste to be collected by the body responsible for its management, we sought to know if residents deposit waste in places indicated by the municipal council, and the following was found illustrated in graph 5.

Chart 5: Deposition of solid waste in old torrone at the locations indicated by the municipal council.



Source: Author, (2023)

It was found that indeed most of the residents deposit their solid waste in places where the municipal council does not collect it, as about 60% stated so. This fact demonstrates once again that residents have contributed in ways that trigger environmental impacts, which directly and indirectly affect the public health of the neighborhood.

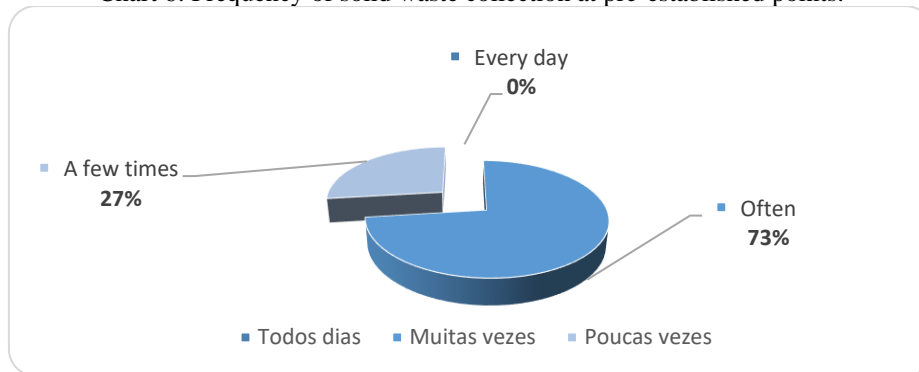


On the other hand, the Municipality's solid waste collection system has its share of faults, as the deposit points are far away, and the waste takes a long time to be collected, as we will see below.

5.2 ACTION REVIEW OF THE COUNCIL'S SOLID WASTE MANAGEMENT SYSTEM IN THE OLD TORRONE NEIGHBORHOOD

As a way of analyzing the actions of the municipal council's solid waste management system in the neighborhood under study, we sought to know about the frequency of waste collection in this neighborhood, and the result presented in graph 6 was obtained.

Chart 6: Frequency of solid waste collection at pre-established points.

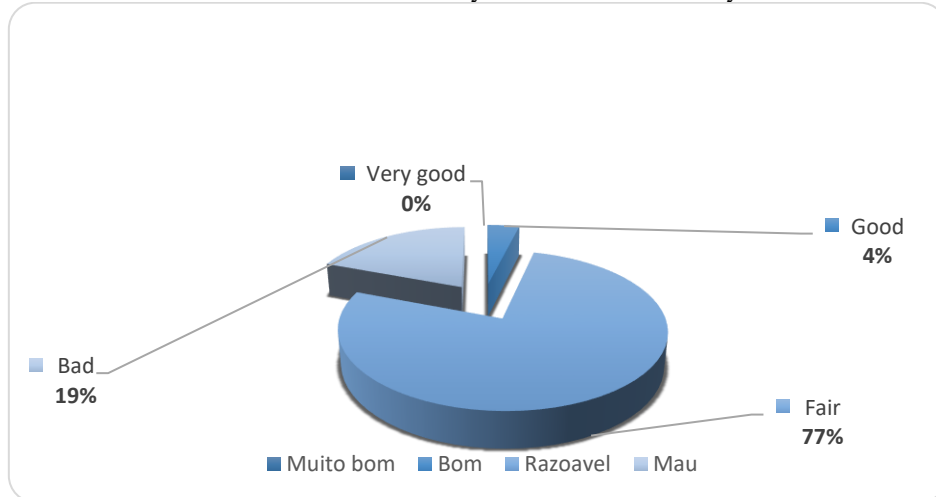


Source: Author, (2023)

It is understood that the system collects solid waste often (per week at least two to three times), as about 73% said so. Only 27% stated that the system collects the waste few times (per week, less than twice). In conclusion, these results show that there is no regular collection of solid waste, so there has been an accumulation of solid waste on the ground, because it has filled the garbage containers or by depositing it on the ground (however the amount that is located on the ground in these places would fill the containers and there would be a lot left over). Therefore, it is thought that it would be good if the collection was done on alternate days or every day.

Finally, we sought to evaluate the solid waste collection service provided by the City Council to this neighborhood. And the following was obtained as shown in graph 7 below.

Chart 7: Evaluation of the city council's solid waste system.



Source: Author, (2023)

Most residents assess the solid waste management service provided by the municipal council as reasonable, as about 77% said so. This fact is due to the deficiencies it presents, such as: poor coverage (little coverage of the neighborhood) of the system and delay in the collection of solid waste, allocation of small containers and in reduced numbers (not being able to respond to the demand given the increase in solid waste production in the neighborhood under study).

The majority of residents, about 69%, believe that the inadequate management of solid waste is generating public health problems, due to the proliferation of disease vectors and bad smell generated from decomposing waste caused by open dumping, which contributes to the low quality of life of the population. The diseases that are being generated, especially in rainy times are diarrheal diseases, headaches and malaria, as conditions are created for flies to proliferate, as well as creating places with standing water in the dumps with waste that retains water from the rains (bottles and cans, for example) creating conditions for the proliferation of malaria. Buried sharp solid waste (shards of glass bottles, zinc scraps, old iron) creates conditions for sores and even tetanus.

6 FINAL CONSIDERATIONS

Based on the results obtained in the research, it was found that solid waste management in Bair-ro Torrone Velho, in the Municipality of Quelimane City, presents flaws in several aspects, directly affecting the quality of life of the population and reveals



the importance of efficient solid waste management to improve the living conditions of the local population.

During the period analyzed, several challenges related to solid waste management in the Torrone Velho neighborhood were identified, such as the lack of adequate infrastructure for the collection and treatment of waste, the inadequate disposal of waste on public roads and the lack of community awareness about the importance of separating and recycling materials.

However, significant efforts and progress were also observed in this area. Sensitization and environmental education actions were implemented to raise awareness among residents about the importance of proper solid waste management. In addition, partnerships have been established with local and international organizations to improve waste collection and treatment infrastructure in the neighbourhood.

These initiatives have resulted in concrete benefits for the quality of life of the community. There has been a significant reduction in the presence of solid waste on the streets, improving the visual appearance of the neighborhood and contributing to the reduction of public health risks. In addition, awareness of the importance of waste separation and recycling has increased, promoting environmental sustainability and resource utilization.

However, it is important to emphasize that solid waste management is an ongoing challenge and that there are still aspects to be improved. It is necessary to invest in waste collection and treatment infrastructure, promote active community participation and strengthen partnerships between the public and private sectors. In addition, environmental education and awareness-raising must be constantly reinforced to ensure long-term sustainability.

In conclusion, solid waste management has a direct impact on the quality of life of communities. The case study of Bairro Torrone Velho in Quelimane, Mozambique, demonstrates the importance of efficient and sustainable solid waste management to improve the living conditions of the local population. The efforts made in this period have resulted in tangible benefits, but also highlight the need to continue investing and strengthening waste management measures to achieve even more significant results.



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