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Research Article

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Analysis of Compliance of Bissau (Guinea-Bissau) MSW Management to Un SDGS

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Abstract

The problems related to solid waste today is causing the quality of life in large urban centers to deteriorate and it's proven that addressing this challenge holistically is paramount since it involves multifaceted of human activities. We identified that in Guinea-Bissau majority (42%) of waste organic corresponding to quantities to 84 tons. It was unveiled the environmental protection (LBA No. 1/2011) is the main legal document defining the framework for solid waste management at the national level in the country. It was discovered that the City Council of Bissau (CMB) faced serious problems in adequately providing urban cleaning services, due to insufficient funds couples with another challenge of how to manage and control CMB services is due to the lack of human resources. The study recommends updating the municipal code of conduct, and effective participation of NGOs and public organizations in the management of MSW in Bissau as a sustainable in conformity with UN SDG framework as remedy and above all implementation of the "polluter pays" principle at all level of the community.

Keywords: Municipal Solid Waste Morphological Composition, Integrated Management, Municipality, Financial Aspects, Social Aspects, Technological Aspects.

Introduction

The increase in the world population and the frequent need to meet the needs of today's society without compromising future generations (sustainable development) is proving to be a very challenging task. Since natural resources tend to decrease and some are even predicted to be exhausted, today's society must reinvent itself and take precautions in various sectors of extraction, transformation and consumption of natural resources over time. Society must also learn to deal with the waste that arises during these processes.

Every year, 2.01 billion tons of Urban Solid Waste are produced in the world, of which at least 33% do not go to a destination considered environmentally correct (Kaza et al., 2018). Technological advances in recent decades have significantly impacted the relationship between Man and the environment. The trivialization of consumerism to sustain new standards of living has created environmental and social problems and, consequently, will create the same problems, or even greater ones, for future generations, if the current standards of living remain the same. It cannot be ignored that problems arise related to different types of waste produced as a result of consumption (Rohde et al., 2012) [1].

Managing waste, especially urban solid waste (MSW), is not an easy task even for developed countries, because the rate of waste production per person has increased significantly and, in turn, the number of places where it can be disposed of is decreasing. The cost of preventing environmental risks is increasingly high. There are difficulties in adapting the different systems in an integrated and sustainable way and also in implementing the different measures, whether regulatory, economic, educational or

social, by the different agents involved in the urban waste management process. Industrialization, lifestyle and socioeconomic level of a society have a strong influence on the quantity and type of waste generated and, when it is not disposed of in an environmentally correct way, it becomes a threat to public health. Waste is responsible for the various environmental impacts that are currently occurring. There is talk of tons of waste circulating in the oceans, tons of waste being burned in the open air every day (a very common reality in countries without a waste management system) and tons of waste being buried every day. One of the greatest challenges facing today's societies is to reconcile economic development with the maintenance of environmental and ecological processes.[2].

While, on the one hand, the environment is the means of sustaining human activities, providing resources and assimilating waste, on the other hand, this dependence has led to several environmental problems, the result of inadequate management and misuse of various natural resources. Climate change and its effects, the scarcity of resources such as fossil fuels and water, the significant loss of biodiversity and the problems associated with the management of solid waste and effluents, indicate that the planet's carrying capacity is at its limit and that urgent measures must be adopted to reverse the situation. One of the most visible signs of this problem is the issue of solid waste.

Population agglomeration, mainly in urban areas, combined with consumption patterns, has been worsening the planet's natural capacity to absorb waste. In the case of African countries, the phenomenon of rural exodus has been notorious, characterized by the large migration of the rural population to urban areas. It is estimated that in the next 40 years the African population living in cities will reach 900 million inhabitants. On the African continent, the average waste generation per inhabitant varies between 0.5 and 0.8 kg per day, depending on the region. In other words, the richer and more urbanized the country, the more waste is generated [3].

Objective of the Study

To develop an adequate urban waste management system in the city of Bissau, consistent with the principles and SDGs, aimed at preserving the environment and improving the quality of life of the population.

Materials and Methods

Object of study. The city of Bissau, the capital of Guinea Bissau, is located in the estuary of the Geba River (Fig. 1), 80 kilometers from the Atlantic Ocean (coordinates: 11°51' north latitude and 15°36' west longitude), the population (permanent residents) of Bissau is more than 388 thousand people (data as of November 1, 2023). The terrain around the city is low-lying and swampy. The city's climate is savanna (almost on the verge of transition to monsoon), with a rainy season from June to October and extremely high humidity (average 67%) throughout the year. The wind is predominantly from the south and south-west, and the average air temperature is 26°C.

Autonomous from a political and administrative point of view, the sector of Bissau is distributed among numerous neighborhoods scattered throughout its territorial space of 77.5 km2.

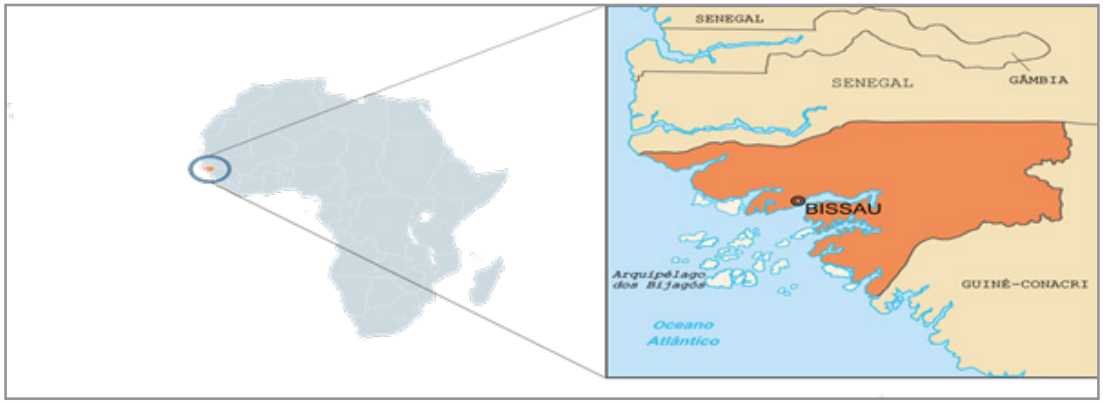

Figure 1: Location of Guinea-Bissau on the African continent and the city of Bissau by country [4].

The research method was based on the results of observations, collection and analysis of bibliographic data, analysis of the legislative framework for urban waste management in Guinea-Bissau: Environmental Protection Law, regulations of the Ministry of Environment of Guinea-Bissau, Complex Waste. Flat Solid Waste Management (PGIRS) (Bissau, 2018) [5]. Collection of factual information (requesting data from local authorities and the Ministry of Environment) and analysis of remote sensing images and cartographic information.

Results and Discussion

Analysis of the Current Situation with Municipal Waste in Bissau

In Guinea Bissau, waste management is carried out in accordance with the Basic Law on Environmental Protection (LBA), and Law No. 1/2011, recently approved by the National People's Assembly. The LBA Law is the main legal document defining at the national level the fundamentals of solid waste management.[5] Including in Art. 21 of the Law establishes that waste, including toxic waste, can be used as sources of raw materials and energy in order to reduce their volumes by taking the following measures:

- Development of new clean technologies,
- Introduction of preventive methods aimed at processing and reusing products as raw materials,
- Use of fiscal and financial instruments that encourage the recycling and use of waste and wastewater.

Responsibility for defining and implementing environmental policy lies with the Directorate General of the Environment (DGA), linked to the Secretariat for Environment and Sustainable Development. Among other things, the direct responsibilities of the DGA include cooperation in defining waste management policies and encouraging the development of new environmental technologies (source PNUD, 1997) [6].

In accordance with local municipal legislation, the Department of Sanitation is responsible for providing services for the collection, transportation and final disposal of solid waste in a manner consistent with the policies and strategies defined by the DGA, including the form of financing and delivery of services (NA MABA, 2010). As the agency responsible for urban cleaning services in the municipality of Bissau, the city council is also responsible for covering all costs associated with putting the system into operation.

In table 1 presents city services for city sanitation - collection and cleaning of city waste, and the parties responsible for their implementation.

Table 1: Urban cleaning services in the municipality of Bissau and relevant responsible persons

Existing city cleaning services in the municipality	Responsibility measures		
	Bissau City Council (CMB)	Contract with third parties (private companies)	Manufacturer
Household waste collection	X		
Collection of special waste - crushed stone	X		
Special waste collection - tree pruning	X		X
Collection of waste from medical institutions	X		
(non-hazardous waste)		X (thermal neutralization of hazardous and infectious waste)	
Collection of waste from ports and airports			X
Industrial waste collection			X
Commercial waste collection	X	X	
Sweeping public roads	X		
Cleaning gutters and drainage ditches	X		
Cleaning of public parks/ squares/gardens	X		
Market cleaning	X		X (internal cleaning)
Waste treatment	X	X	X
Final waste disposal	X		
Other services – (waste removal under special contracts)		X	

Source: Bissau City Council (CMB, 2012) [7]

As can be seen from table. 1, at the municipal level of Bissau there are no measures for the effective management of municipal waste.

Organizational and Financial Aspects of Waste Management in Bissau

According to CMB (2022), Bissau produces about 200t. waste per day, with a per capita generation level of 0.5 kg/day. The morphological composition of waste is presented in the diagram (Fig. 2).

Based on Bissau City Council and Lay Volunteer International Association, LVIA, 2016.[8]

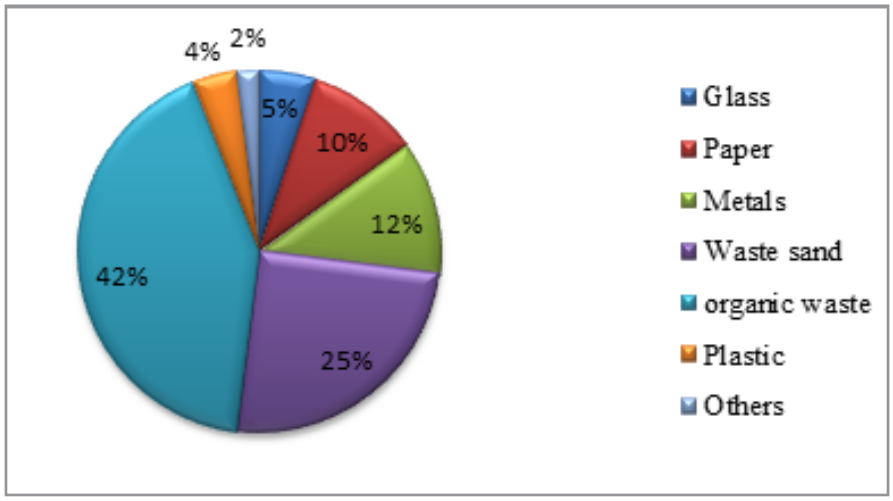

Figure 2: Morphological Composition of municipal waste in Bissau

Note: * The "other" category includes waste rubber, fabric/rags/textiles, which, due to low individual representation, were grouped into only one category.

Source: compiled by the authors

As can be seen from (Figure 2), municipal solid waste consists mainly of organic matter, soil, plastic, textiles, glass and metals. Of these, the organic fraction, earth and sand (swept from streets, most of which are unpaved), constitute the largest portion.

The large volumes of waste generated are mainly due to the significant population growth observed over the past two decades (CMB, 2020). Combined with indiscriminate land occupation, this has serious consequences for the city's poor urban sanitation system, as it is not accompanied by planning and expansion of infrastructure that guarantees the minimum quality of required services (DGA, 2020) [8]. For clarity, (Table 2) presents a comparison of some parameters of urban cleaning services in Bissau for 2010 and 2020.

Table 2: Comparison of sanitary cleaning parameters in Bissau

Parameter	2010	2020
Population	277.848*	387.909*
Annual MSW production/generation (tons/day)	99**	150**
Percentage of population served by a MSW collection system	70%**	55%**
MSW generation rate per capita (kg/inhabitant/day)	0,4**	0,4**

Source: *(INEP, 2020), **(NA MABA, 2010).

The Code of Regulations provides for a waste management fee, which is intended to cover the cost of waste collection and cleaning services from revenues from various municipal fees such as market fees, registration fees, occupancy fees, licenses and inspections, and other services provided. However, at the moment there is no fee for both residential and non-residential premises, although its implementation has been widely discussed among local authorities [5]. However, no consensus has yet been reached that would lead to its approval. This is due to several factors that deserve attention:

- Lack of legal support and criteria for calculating rates (calculation basis),
- Poor quality or limited coverage of cleaning services and, as a result, dissatisfaction and opposition from the population to charging fees.
- Uncertainties associated with improving the quality of services while implementing the collection level

Overall, according to CMB (2020), the daily cost of urban cleaning services is in the range of $1,246.8 (equivalent to 750,080 XOF in local currency). Thus, the resources allocated to urban cleaning service costs are limited and can barely cover the costs associated with operating and maintaining the system. As a result, there are no financial resources left to invest in both training and infrastructure expansion to meet the growing demand for the services in question.

Technological and Social Aspects of Waste Management in Bissau

Waste recycling is one of the methods used to reduce the environmental impact of waste and also as a way to reduce the

burden on natural resources for a more sustainable economy (Santos, 2012).

Guinea-Bissau does not have an organized urban waste management and treatment system, so the methods used to collect or reuse waste are few. However, some of them arose as a way to overcome social inequality and a source of additional income for families. It is also worth emphasizing that the economy of Guinea-Bissau is largely dependent on imports of products from foreign countries, mainly from Senegal, Gambia and Guinea-Conakry. Most of these products are essential, resulting in large numbers of consumers and associated large amounts of waste. Many of these products have packaging that is very popular among the population. Waste is a source of income for many families, ultimately becoming almost invisible in the eyes of government officials [9].

Thus, different types of waste use and disposal apply to different types of waste identification in a country:

- **Plastic and Glass Waste:** Glass and plastic bottles (up to 1 liter in volume) are highly valued by the population. Typically, they are used for storing or selling products (for example, palm oil, olive oil, lemon juice, etc.), since there is often not enough money to buy/sell the entire product in packaged form.
- **Metal Waste:** Non-ferrous metal waste, namely aluminum soda and beer cans, is used for the artisanal production of pots and some kitchen utensils at the request of the buyer. Molds of different sizes are placed in a hole dug in the ground, into which molten metal is poured.
- **Waste paper/cardboard:** The population uses waste paper for smoking fish, lighting firewood and charcoal. Cardboard often serves as lids for reused bottles, as well as for preparing bedding areas. Despite this, paper and cardboard can still often be found on city streets, since its use is negligible.
- **Bioorganic waste:** Bioorganic waste, namely plant residues, are used for domestic feed, the branches obtained as a result of pruning serve as fuel for the production of charcoal, palm branches, after trimming and drying at room temperature, are used to make traditional panicles [10].

Organization of a System for Collection, Removal and Disposal of Urban Waste

For the collection of municipal waste in Bissau, CMB provides stationary waste containers at strategic points in the city, usually in places where waste collection vehicles corresponding to the various collection areas of the Bissau City Council (CMB) can be accessed (Fig. 3) or in the Praça area (centre). city), or on the main avenue.

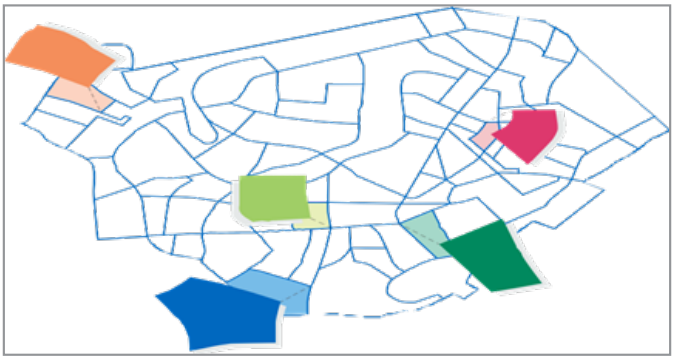

Figure 3: Map of the city of Bissau showing the assembly areas of the Bissau City Council (CMB).

However, the location of these points is also inconvenient for the majority of the population living in hard-to-reach areas. Due to the insufficient number of containers, as well as the low frequency of collection, they often become overfilled, which leads to an accumulation of garbage on the roads, which is carried by animals and people looking for recyclables (Figures 4 and 5).

Therefore, practices such as burning and dumping waste are common in most areas of the city. The practice of dumping waste on vacant lots, public roads and drainage canals is also very common (Figures 6 and 7).

Figure 4: Container overfilled. Rice.

Figure 5: Collector looking for recyclable materials

Figure 6: Accumulation of garbage on the road

Figure 7: Drainage channel clogged with debris.

Source: author's photo

In Bissau, only traditional mixed waste collection is carried out, with waste collection services limited to the main areas of the city centre. According to CMB (2022), out of 200t. waste, about 55% of all waste generated in the municipality is collected daily, 50% of which comes from the city center and only 5% from peripheral areas.

According to the same source, the low percentage of coverage of peripheral areas by centralized waste collection is mainly due to the inaccessibility of the streets, which are narrow and unpaved. In addition, CMB also points out the lack of cooperation from the public in properly packaging waste, with most of them simply throwing waste in vacant lots [11].

In table Figure 3 shows the frequency of collection, timing and type of equipment used to perform sanitation services in Bissau.

Table 3: Frequency of waste removal and equipment used

Frequency	Shift work	Pickup hours	Equipment used	Sector
Daily	I	08.00-16.00	2 collection tractors and 1 trailer with a volume of 3 m³.	-
Daily	II	22.00-09.00	2 trucks with a carrying capacity of 7 tons each, 2 container ships of 6 m³ each and an escort truck with a volume of 3.5 m³.	Markets in remote areas

Source: City Council of Bissau (CMB)

As can be seen from (Table 3), the frequency of waste removal is daily, but collection and removal are carried out irregularly due to lack of maintenance and constant breakdowns of the vehicle fleet. Of the entire fleet of vehicles involved in the sanitary cleaning of the city, only 8 out of 17 units are in working condition (see Table 4). Since the logistics of waste collection and removal are disrupted, containers remain filled in accessible places for a long period, sometimes even for several years (NA MABA, 2010) [11].

Teams working to collect and remove waste often have a complete or partial lack of personal hygiene and personal protective equipment.

Table 4: Inventory of materials and equipment of the municipality

Description	Number of transport units		Owned by CMB (C) / leased (A)	Service CMB/ third party.
	работающие	неисправные		
Car seal	0	3	C	CMB
Open back truck or dump truck	3	3	C	CMB
Tractor with tipper trailer	2	0	C	CMB
Loader	1	0	A	The third side
Container ships	2	2	C	CMB
Auxiliary light vehicle	1	1	C	CMB
Bulldozer	1	0	A	The third side

Source: compiled by the authors.

Collected mixed waste is transported to authorized landfills for disposal. In the city of Bissau, until 2022, there were two landfills, but currently, since one of the landfills has exhausted its resource and is practically out of operation, only the landfill lo-

cated in the municipal district of Antula, 10 km from the city center, is functioning.

Due to the absence of a centralized separate collection system or subsequent sorting at permanent disposal sites, all collected waste, including household waste, market waste, crushed stone, and non-infectious medical waste, is disposed of at this landfill [12].

Disposal procedures are limited to dumping and incineration of waste in order to extend the useful life of the landfill. CMB uses a bulldozer, dump truck and excavator to provide burial services [13].

The territory does not have an isolation fence, and the surveillance service is random, which ensures access to the territory by unauthorized persons and animals, as shown in (Fig. 8).

Figure 8: Official dumpsite of Bissau (Antula region)

Conclusions

Based on the analysis, the following conclusions were made.

1. The Law on Environmental Protection (LBA No. 1/2011) is the main legal document defining the framework for solid waste management at the national level. However, this document needs to be updated as it was developed without considering the reality of urban densification that city governments are currently facing.
2. Guinea-Bissau does not have an organized urban waste management and treatment system, so the methods used to collect or reuse waste are few. Some of them arose as a way to overcome social inequality and a source of additional income for the local population.
3. At present, only traditional mixed waste collection is carried out in the City of Bissau, with waste collection services limited to the main areas of the city center. According to CMB (2022), out of 200t. waste, about 55% of all waste generated in the municipality is collected daily, 50% of which comes from the city center and only 5% from peripheral areas.
4. The City Council of Bissau (CMB) has faced serious problems in adequately providing urban cleaning services, due to insufficient funds collected from the population in the form of city sanitation tariffs, which only cover part of the operation and maintenance costs. Overall, according to CMB (2020), daily costs for urban cleaning services are in the range of $1,250 (equivalent to 750,080 XOF in local currency).
5. Municipal waste management in Bissau is carried out spontaneously at the initiative of the local population, in suburban areas, garbage collection is carried out only by residents. As a result, empty lands and public roads serve as places for storing waste, which is a source of infectious diseases and the breeding of insects and rodents.
6. The government program to increase the efficiency of urban sanitation is implemented in Bissau only during the rainy season due to the threat of the spread of infectious diseases associated with the presence of waste, primarily malaria.
7. The ability to manage and control CMB services is due to the lack of human resources, both in terms of qualifications and quantity, with the enterprise often having to resort to hiring temporary staff to provide services.
8. Policies to encourage the recycling of waste components, differentiated collection and public awareness campaigns in Bissau are usually implemented by international partners, non-governmental organizations or even the youth community.

Measures to Improve the MSW Management System in Guinea-Bissau

Taking into account the limitations and shortcomings identified at the diagnostic stage, the following measures and actions are proposed: Update the municipal code of conduct, Ensure a higher degree of participation of ONGs and public organizations in the management of MSW in Bissau, it is advisable to introduce models of the tariff regime for charging for the provision of services for the management of solid waste, taking into account the reimbursement of all costs (the “polluter pays” principle), conduct a waste inventory and create a database to collect information about the entire city waste treatment system, It is necessary to encourage selective collection of the following fractions: metals and plastics (PET) the cost of glass containers should be included in the deposit price of the goods, additional investments in the development of the system of individual and small businesses, including waste sorting, in the field of processing secondary raw materials, with the construction of a sanitary landfill that will serve the entire city, the dumpsite must be closed, thereby starting requalification of the dumpsite area, ensuring

safe collection and quality of groundwater. It is also worth remembering that organic waste is produced in large quantities in the country (42% in Bissau alone, corresponding to 84 tons), but is used very little. From this perspective, composting this type of waste may be one approach that can help reduce the volume of organic waste sent to dumpsite.

Authors' Contributions

All authors made an equivalent contribution to the publication. Specific tasks include Nantungue Fernando, Kharlamova M.D. conducted the analysis of the MSW management system in Bissau (Guinea-Bissau) in the light of sustainable development goals.

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