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SOLID WASTE MANAGEMENT: A CASE OF LIBYA

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Abstract
Solid waste is defined as the unwanted byproducts of human activities which can be in both commercial and domestic human activities. Solid waste can be very toxic and dangerous to human health if not adequately managed through various processes of what is known as solid waste management. Solid waste management is the process that is defined by the collection and treatment of solid waste to ensure the protection of both human and environmental health. Solid waste management is a process that is defined as crucial for public health and the individual health of the people in a society. Solid waste management is however a process that has significant challenges to be implemented adequately, especially in underdeveloped parts of the world. This study is a comprehensive investigation into the state of solid waste generation and the efforts of solid waste management in Libya; its challenges and efficiency, as well as the recommended processes for ensuring it is further improved.

Keywords: Libya, municipal waste, solid waste, solid waste management,

Introduction

Solid waste is defined as the produced unwanted products through human activities which have been discarded by the people of a given society. Solid waste is a category of waste that is characterized as either the by-product of a process or the discarded materials which may be a result of usage and processing in both domestic sectors and commercial sectors. Solid waste is commonly known under the following categories (Kudelas, 2018):

- Garbage: These are the kinds of waste that are categorized as solid waste as a result of food processing and waste disposal.
- Rubbish: These are the kinds of waste that are considered solid waste which consist of combustible waste and non-combustible waste which primarily do not include garbage or food waste.
- Refuse: These are the kinds of waste that include both the garbage category of waste and the refuse category of waste.

- Litter: These are the kinds of solid waste that consist of discarded objects and odds such as discarded bottles, discarded wrappings, discarded paper, etc.

Solid Waste Management

Solid Waste Management (SWM) is a process that is defined as the collection and treatment of solid waste using methods that will ensure the environment is managed properly (Chen et al., 2021). SWM is a process that is been carried out using several processes depending on the kinds of waste being treated as well as the factors surrounding the waste, such as environmental factors, socio-economic status of the waste-generating society, and other such factors (Oman & Gebril, 2018). SWM process includes a process that seeks to recycle collected waste and also processes that carry out permanent disposal of the collected waste. While not all SWM efforts are efficient and adequate, the improper processes of SWM can lead to further problems and challenges that the solid waste before such efforts did not pose to society, inadequate SWM efforts can create more pollution to the environment by creating unsanitary conditions surrounding the treated waste. Inadequately treated waste may cause the spread of diseases through factors such as pathogens, insects, and rodents. Adequate SWM strategies pose a complex and technical challenge to societies globally, which may extend to administrative problems, economic problems, and social problems in society (Das et al., 2021).

Brief History of Solid Waste Management

The ever-growing global population and the increase in the consumption habits of our species have led to an ever-growing of solid waste generation throughout history. All aspects of human life are associated with the generation of waste, hence this puts the generation of waste as an inevitable process of life for humans. Waste generation for humans is carried out on a wide scale and on a range of spectra which covers day-to-day solid waste to the creation of highly toxic waste such as chemically reactive waste through human activities and processes. Waste generation being a process that is associated with living means humans must have indulged in waste management for a very long time, and over the course of history several processes of SWM have been introduced and developed, these include recycling, incineration, dumping, and other such SWM methods (Singh, 2019).

One of the earliest organized efforts of SWM in a society can be traced to far back 500 B.C in present-day Athens, where each household is tasked with the responsibility of collecting their generated waste to a disposal site beyond the city walls (Soni et al., 2022). The roman empire took the efforts of SWM a little bit further in development by the creation of solid waste pick-up utilities for the SWM process to be carried out for the society collectively, collected waste using horse carts were transported to a far open pit for disposal. These kinds of waste disposal were the primary methods and techniques for SWM in history, these techniques of SWM continued until the 1700s when solid waste started becoming a major challenge in most urban societies and studies began taking place to find more adequate ways to ensure SWM techniques are developed to mitigate these challenges, this will eventually lead the world into the sanitation era in the context of SWM (Kabera et al., 2019).

The modern concept of SWM emerged in countries like the United States of America at the turn of the 20th century with the development of solid waste collection efforts and disposal for almost all cities of the country where collected waste is then treated through various techniques such as the use of landfills, ocean disposal, and incineration (Kumar & Agrawal, 2020). SWM was further developed after the second world war which is because the matter of waste generation and the risks associated with it were further increasing around the world's urban areas, chemical-related consumptions increased, and the composition of solid

waste generated became more and more complex, and toxic (Nwankpa & Scandrett, 2020). Development of SWM techniques such as sanitary landfills typically defined the methods of SWM in the 1950s, this is a method of SWM that engages in spreading waste in landfills using thin layers over a large spread of land. Landfills were later identified as groundwater contamination techniques of SWM, and the remediation of groundwater after contamination is an extremely challenging endeavor. This has now led to the development of more complex and more sustainable SWM techniques around the world through recycling methods and much more careful landfill techniques execution which considers the nature of the solid waste and possible contact with groundwater.

Challenges of SWM

There are several issues and challenges which are associated with the process of SWM across the globe, however, the most significant concerns of SWM are aspects of the endeavor that are concerned with waste generation, inadequate waste collection, waste transportation, and waste treatment and disposal methods applied in SWM (Chen et al., 2021). The challenges of SWM can be outlined and overviewed as follows:

- Waste generation: This is a challenge of SWM which entails the rapid generation of waste which leads to overwhelming waste generation by the general public. This challenge is prevalent in most urban areas of the world, where the generated waste often overwhelmed the facilities put in place to manage the waste of the city.
- Waste collection: SWM processes generally include a collection of generated was as the initial stage of adequate SWM processes. Inadequate waste collection is one of the most challenging factors of SWM processes, most urban areas and cities lack adequate facilities and infrastructure for good waste collection which leads to people resorting to inadequate processes of waste collection.
- Waste transportation: logistics is an intrinsic part of adequate SWM, this requires the movement of solid waste from point to point, such as from point of collection to point of treatment and or point of disposal. A good SWM waste transport system is one which is equipped with adequate transportation and communication services during the processes of the waste transportation stage in SWM.
- Waste treatment/disposal: operational efficiency for the treatment and disposal of solid waste is one whose critical importance cannot be overemphasized. SWM processes are often faced with adequacy of waste treatment and or disposal, it is very difficult and complex to implement a waste treatment or disposal which has zero aftermath consequences on the environment.

Solutions to The Challenges of SWM

Solutions to the challenges faced by SWM processes are often solutions that require individual cases to have their own tailored solution over a general framework which is presented as an SWM framework. Adequate SWM processes require the proper analysis of a society before an SWM process in being applied, such analysis involves the analysis of the socioeconomic standing of the society, the kinds of waste being generated by the society, and the available resources for the SWM process on such waste (Chen et al., 2021). Solutions to the challenges of SWM in any locality require the appropriate study of the specific aspect of the existing SWM framework that requires improvement, or if the entire framework requires an overhaul then that can be applied too. There are however designed framework that considers the general outlook on having an adequate SWM process for a society, one such framework is the proposed framework by Vitharana (2014) as illustrated in Figure 1.

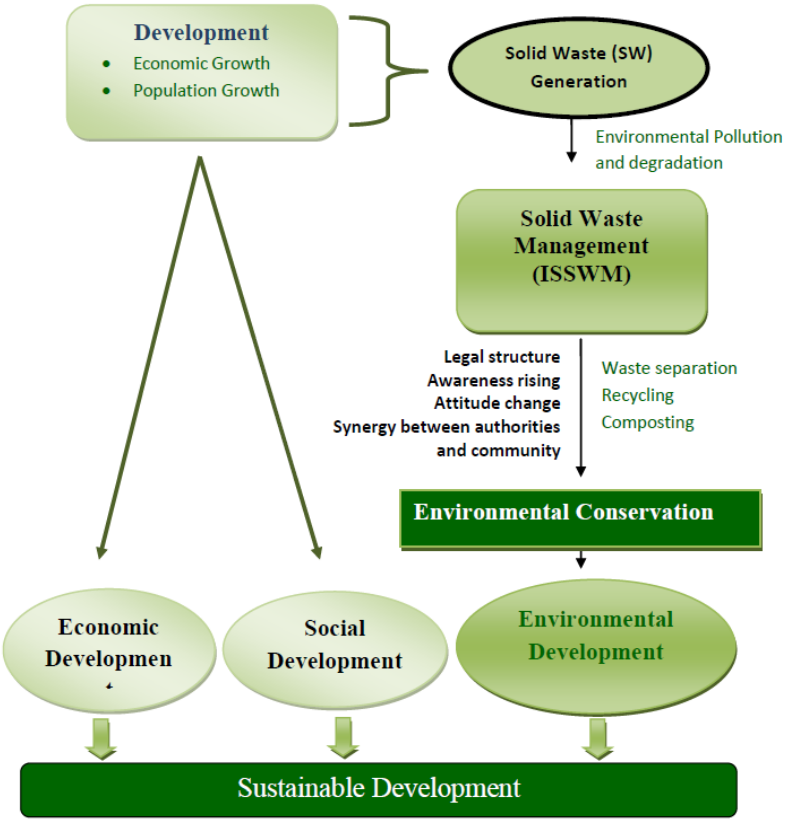

Figure 1: A framework for adequate SWM (Vitharana, 2014).

Waste management and disposal is a very significant global challenge, the majority of the world's produced solid waste is disposed of through unhealthy and unsustainable methods such as open landfill dumping and incineration (Nanda & Berruti, 2021). Inadequate and improper waste management comes with significant challenges to society, these then get fused with the inadequacy of the waste management processes to become even more complex issues for society. Challenges of solid waste management are particularly more severe in developing and underdeveloped parts of the world, with the absence of adequate waste management strategies and techniques such as recycling strategies and energy production through waste management of solid waste to ensure environmental sustainability and protection (Das et al., 2021).
Solid waste management has become a complex process that is tackled with multidisciplinary approaches in society, this is because the issue of solid waste entails aspects of environmental sustainability, technological advancements, social factors, health risks, and others. Adequate solid waste management ensures that many aspects of society are secured well; economy, public health, and environmental sustainability (Abdallah et al., 2020).

Global Solid Waste Management

The generation of solid waste across the globe has been on a constant rise, the rise of solid waste generation has been associated with the inefficient and improper use of energy and resources (Yu & Li, 2021). Studies have shown a correlation between economic growth, urbanization, population explosion, and high industrialization rates with the rapid generation of solid waste. Urban population around the world has been reported to contribute to the estimated production of 70% of the global waste volume. In 2016 alone the

world has been reported to have generated a total of 242 metric tonnes of solid waste, many countries around the world are known for carrying out SWM efforts have been only responsible for an estimated 72% of the world's solid waste generated (World Bank Group, 2018).

Developing countries of the world have been reported to spend less than 0.5% of their gross national per capita on SWM (Devit et al., 2016). The majority of the world's urban areas are still practicing traditional SWM practices which involve the use of landfills, incineration, and other age-old SWM practices which are not sustainable in the long run, but these methods are still being used because they are easier to carry out and are often financially less demanding to carry on (Sharma & Jain, 2020). These traditional methods and techniques of SWM cause challenges of air pollution, groundwater pollution, emission of landfill gasses, and other such harmful effects on the environment and public health. The global trajectory estimated is that the world will have its population get doubled by the year 2050, and that implies wage generation will also significantly increase, this requires the development of methods and techniques that will effectively manage the waste being generated right now and prepare for the significant increase of waste generation and demand for adequate SWM (Nanda & Berruti, (2021),

Solid Waste Management in Libya

Solid waste generation in Libya happens generally through commercial waste, residential use, and other forms of institutional land usage (Alsadey & Mansour, 2017). Solid waste management processes in Libya is a process which involve the waste generation, storage of waste, collection of waste, transportation of waste, processing of waste, and final disposal of waste. Solid waste management in Libya is primarily a function of the local public bodies instituted by the government of Libya. Solid waste management in Libya is considered to be both challenging and inadequate in most of the urban areas of the country, most waste management processes in the cities of Libya still lack adequate waste generation, waste collection, waste disposal, waste recycling, and all other aspects of adequate waste management (Alkishriwi, 2021).

The conventional generation of solid waste in Libya has seen a significant change in direction in recent times, the recorded volume of waste generated in a relatively short period of time of the wars and conflicts since the Arab spring of 2011 has been estimated at about 82 million tons of solid waste (Kridish et al., 2021). Solid waste in Libya is a very age-long problem, especially in the urban areas of the country, generally speaking, Libya generates about 3.2 million tons of solid waste which is estimated at about a generation of 1.25 kilograms of waste per person daily across the country. Improper and inadequate waste management practices in Libya primarily involve the use of poor and inadequate disposal of waste through landfills and a significant absence of waste recycling practices. Inadequate solid waste management in Libya presents the following challenges for the country (Ali & Ezeah, 2017):

- Economic challenge
- Health challenge
- Social challenge
- And environmental challenge

In 2019, the United Nations Development Program (UNDP) declared Libya as a country facing a waste management crisis which was primarily due to the ongoing conflict and war in the country, this resulted in an immense generation of waste with little to no effort of solid waste management. Due to the ongoing conflict even the existing inadequate waste management framework of the country could not operate as it normally does, the following factors caused the waste management bodies to become incapacitated during these periods (Ibrahim, 2021):

- Waste disposal companies are unable to operate across the country efficiently.
- Territorial disputes are causing authority clashes in the waste management frameworks.

The Surge of Solid Waste in Libya

Poor waste management of solid waste is not the only solid waste challenge experienced by Libya. Libya is also experiencing an unprecedented surge in their solid waste generation, the significant amount of solid waste generated because of the ongoing conflict is now complemented by other factors which are also increasing the generation of solid waste in the country. Some of the factors which are contributing to the surge in solid waste generation in Libya include (Omran & Gebril, 2018):

- Fast population explosion and growth, with an annual estimate of 2.2%.
- Rapid urbanization is significantly influenced by the conflict, with an estimated rate of 80% in the past decade.
- The rapid industrialization of the urban areas in the country.
- Poor and unsustainable domestic consumption habits, it is estimated that 60% of the solid waste in Libya is generated through the use of plastic.

Solid Waste Management Challenges in Libya

The inadequate and poor waste management practices in Libya can be regarded as a cumulation of several factors that result in poor waste management, especially in the urban areas which are associated with high solid waste generation in the country. The main challenges which cause inadequate solid waste management in Libya can be outlined and summarized as follows (Badi et al., 2019):

- The waste management framework in Libya significantly lacks qualified personnel in their staffing who are adequately trained for efficient solid waste management.
- The waste management framework in Libya is poorly designed and poorly executed for efficient solid waste management.
- Waste management in Libya is riddled with severe mismanagement of resources set out for the proper management of solid waste. This includes the misappropriation of funds due to high corruption practices in the country at large.
- There is a lack of reliance on the efficiency of high-tech infrastructure as is the case in developed countries of the world. Such technology includes waste recycling technologies which ensure the sustainability of the environment during solid waste management cycles.
- The Libyan government and administration also fail to consider solid waste management a critical issue as it is to ensure there are adequate administrative policies in place to treat the issue of efficient solid waste management in the country.
- According to a study carried out by Omran and Gebril (2018), 66% of residents of the urban areas of Libya have indicated they do have not solid waste drop-off points and points of solid waste collection by the solid waste management bodies of the cities.

Environmental and SWM Awareness in Libya

Libya as a country has been associated with inadequate awareness of the issues of environmental management and SWM practices among its populace (Ali & Ezeah, 2021). Libya like most of the underdeveloped countries of the world has several challenges in enabling them to have adequate awareness of the issues of environmental and SWM management practices. These two subjects are subjects that the

people of Libya have high illiteracy and can be seen vividly in practice with the unhealthy and inadequate practices the majority of the people engage in with respect to the management processes (Badi et al., 2021). Lack of adequate awareness of environmental sustainability and SWM practices in Libya have led to considerable undesired losses and impacts, unfortunately, the inadequate literacy and awareness on these topics is not only peculiar to basic citizens, this lack of awareness can also be seen in the people who are tasked with the responsibility of managing SWM and the environment as a whole (Alkishriwi, 2021).

Several studies in Libya carried out on the subject of environmental sustainability awareness and SWM awareness have reported a significant lack of awareness among the general population of the country (Oman & Gebril, 2018). Libya as a country is characterized by unsustainable practices of environmental resource utilization and SWM processes, where the country carries out inadequate waste disposal, inefficient waste management and treatment across the country, lack of adequate policies which will enable adequate waste management practices, and lack of enforcement of the existing policies and regulations on environmental management and SWM (Gebril et al., 2010).

Conclusion

Solid waste management in Libya remains a concerning issue for the safety of the Libyan people economically, public health, environmental sustainability, and social aspects of society. Libya as a country is facing a lot of inadequacies in proper solid waste management that are contributed to by a lot of factors. However, the most significant aspect of the factors which cause inadequate waste management in Libya can be stated to be a lack of an infrastructural framework that is efficiently designed to tackle the adequate management of generated solid waste in the country. The problems of inadequate solid waste management in Libya include a lack of financial resources for the waste management sector, a lack of dedicated human resources, and a lack of technological infrastructure and planning.

There is an urgent need to restructure solid waste management practices in Libya to avoid further deterioration and decay. The following recommendations are to be considered to ensure adequate and sustainable solid waste management in Libya:

- The existing regulations of solid waste management need to be enforced.
- Illegal landfills and dumpsites need to be regulated and reduced.
- Community participation in solid waste management needs to be encouraged among the people of Libya.
- Public awareness and sensitization need to be done to address the hazards and risks associated with inadequate solid waste management.
- The government needs to review solid waste management policies to ensure more is done and the public need to also be held accountable and responsible for inadequate waste management in their own domains.
- Penalties and sanctions need to be introduced to both domestic and commercial waste generation in Libya to discourage poor habits of solid waste generation.
- There is a need for monitoring systems to be set up to monitor waste activity in the country.

References

1. Abdallah, M., Talib, M. A., Feroz, S., Nasir, Q., Abdalla, H., & Mahfood, B. (2020). Artificial intelligence applications in solid waste management: A systematic research review. Waste Management, 109, 231-246.
2. Ali, A., & Ezeah, C. (2017). Framework for the management of post-conflict waste in Libya. European Scientific Journal, 13(5), 32-49.
3. Alkishriwi, N. (2021, May). Feasibility Study of a Waste-to-Energy (WtE) Plant for Tripoli City, Libya. In 2021 IEEE 1st International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering MI-STA (pp. 468-473). IEEE.
4. Alsadey, S., & Mansour, O.(2017) Environmental Impacts of Improper Solid Waste Management in Developing Countries: A Case Study of Bani Walid City, Libya.
5. Badi, I., Abdulshahed, A., Shetwan, A., & Eltayeb, W. (2019). Evaluation of solid waste treatment methods in Libya by using the analytic hierarchy process. Decision Making: Applications in Management and Engineering, 2(2), 19-35.
6. Chen, H. L., Nath, T. K., Chong, S., Foo, V., Gibbins, C., & Lechner, A. M. (2021). The plastic waste problem in Malaysia: management, recycling, and disposal of local and global plastic waste. SN Applied Sciences, 3(4), 1-15.
7. Das, S., Lee, S. H., Kumar, P., Kim, K. H., Lee, S. S., & Bhattacharya, S. S. (2019). Solid waste management: Scope and the challenge of sustainability. Journal of cleaner production, 228, 658-678.
8. Gebril, A. O., Omran, A., Pakir, A. H. K., & Aziz, H. A. (2010). Municipal solid waste management in Benghazi (LIBYA): Current practices and challenges. Environmental Engineering & Management Journal (EEMJ), 9(9).
9. Ibrahim, R. (2021). Waste management in Tripoli: a temporary crisis or a long-lasting imbroglio?. European University Institute.
10. Kabera, T., Wilson, D. C., & Nishimwe, H. (2019). Benchmarking performance of solid waste management and recycling systems in East Africa: Comparing Kigali Rwanda with other major cities. Waste Management & Research, 37(1_suppl), 58-72.
11. Kridish, M., Harhour, K., Abdulshahed, A., & Badi, I. (2021). Logistical Challenges Facing Solid Waste Management In Libya.
12. Kudelas, E. E. D (2018). Assessing The Economy, Environmental And Technical Viability Of Composting For Solid Waste Management In Libya.
13. Kumar, A., & Agrawal, A. (2020). Recent trends in solid waste management status, challenges, and potential for the future Indian cities–A review. Current Research in Environmental Sustainability, 2, 100011.
14. Nanda, S., & Berruti, F. (2021). Municipal solid waste management and landfilling technologies: a review. Environmental Chemistry Letters, 19(2), 1433-1456.
15. Nwankpa, S., & Scandrett, E. (2020). History and contexts of municipal solid waste management in Aba–Recounting the stories of residents. Journal of Environment and Earth Science.
16. Omran, A., & Gebril, A. O. (2018). Municipal solid waste management practices in the central part of Libya. In The Impact of Climate Change on Our Life (pp. 149-165). Springer, Singapore.
17. Sharma, K. D., & Jain, S. (2020). Municipal solid waste generation, composition, and management: the global scenario. Social Responsibility Journal, 16(6), 917-948.

18. Singh, A. (2019). Remote sensing and GIS applications for municipal waste management. Journal of environmental management, 243, 22-29.
19. Soni, A., Das, P. K., & Kumar, P. (2022). A review on the municipal solid waste management status, challenges and potential for the future Indian cities. Environment, Development and Sustainability, 1-49.
20. Vitharana, A. D. (2014). Sustainable Development: A Study of Solid Waste Management for Sound Environmental Development in Hambantota Municipal Council, Sri Lanka. Volume III, 121.
21. Yu, Q., & Li, H. (2020). Moderate separation of household kitchen waste towards global optimization of municipal solid waste management. Journal of Cleaner Production, 277, 123330.