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Exploring the Social, Economic, and Environmental Benefits and Challenges of Sanitary Landfill in the Al Jurf Landfill in Ajman

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ABSTRACT

The Al Jurf Landfill in Ajman serves as the primary waste disposal site for the Emirate since 2006. The landfill processes around 750 tons of waste daily and has accumulated a total of nearly 4 million tons of waste. The waste management process at the landfill is in line with the UAE's Key Performance Indicators and is constantly improving with the adoption of new technologies and processes, such as waste-to-energy, recycling, improved waste separation and collection, and wastewater treatment, aimed at reducing the per capita environmental impact and air quality. The article highlights the efforts made to improve waste management and reduce environmental impact. The advantages and disadvantages of sanitary landfills, waste-to-energy and landfill mining are discussed, with a focus on the benefits and challenges of these methods. The article concludes by emphasizing the importance of the Al Jurf Landfill in sustainable waste management.

Keywords: Al Jurf Landfill**,** sanitary landfills, landfill remediation.

1. INTRODUCTION

Waste management is a critical aspect of modern society that involves the collection, transportation, processing, recycling, and disposal of waste materials. The scope of waste management ranges from handling household waste to disposing of hazardous waste from industrial and medical facilities. The objective of waste management is to mitigate the negative impact of waste on the environment and human health, conserve resources, and minimize costs. This is typically achieved through a harmonious combination of regulations, infrastructure, and public education.

Proper waste management is essential to ensure safe and efficient disposal of waste. This involves an understanding of the various categories and types of waste and the methods required to manage them. Some of the common categories of waste include Municipal Solid Waste (MSW), which includes household waste, food waste, and yard waste. Certain waste materials, such as paper, cardboard, plastic, glass, and metal, can be sorted and recycled. Hazardous Waste is another category of waste that necessitates special handling, including chemicals, batteries, and medical waste that pose a risk to human health and the environment. Industrial Waste is generated by industrial processes and encompasses items such as chemicals, oil, and radioactive materials.

Electronic Waste (E-Waste), which comprises advanced electronic devices that become obsolete and contain toxic materials, is a rapidly growing problem. Organic waste, such as food scraps and yard waste, can be converted into a useful resource through composting and used as natural fertilizer for agriculture. Construction and Demolition Waste (C&D), generated by the construction industry, includes materials such as wood, concrete, bricks, and metals and can be recycled or used as fill material in landfills (Menegaki, M., & Damigos, D., 2018).

Waste management in Ajman, ia an important aspect of the city's overall environmental strategy. Ajman, like the rest of the United Arab Emirates (UAE), has been making significant progress in managing its waste and reducing its impact on the environment. The Ajman Municipality and Planning Department is responsible for overseeing the city's waste management operations. They have implemented a number of initiatives to improve the way in which waste is collected, processed, and disposed of. One such initiative is the implementation of a door-to-door waste collection system. This system helps to ensure that all residential and commercial waste is collected on a regular basis, reducing the amount of litter on the streets and improving the overall cleanliness of the city. In addition, the city has several waste management facilities that are equipped to process and dispose of different types of waste. These facilities include a landfill site, a recycling plant, and a composting facility. The landfill site is used for the safe disposal of non-recyclable waste, while the recycling plant sorts and processes recyclable materials. The composting facility processes organic waste, such as food and yard waste, and produces compost that is used as fertilizer in local parks and gardens.

To further reduce the amount of waste going to the landfill, the city has implemented a number of recycling programs. These programs encourage residents and businesses to recycle their waste by providing them with the necessary containers and collection services. The city also offers education and awareness campaigns to educate the public about the importance of recycling and the benefits of reducing waste. The waste management system in Ajman is making significant progress in reducing the amount of waste going to landfill and improving the city's overall environmental sustainability. The city's continued efforts to improve its waste management practices are helping to ensure a cleaner, greener, and more sustainable future for all its residents.

2. WASTE MANAGEMENT IN UAE

2.1 landfilling

Landfilling is a prevalent method of waste disposal utilized in the UAE. This method is classified into three categories, traditional, engineered, and sanitary landfills. Traditional landfills are the most rudimentary type of landfill and are not equipped with protective features, such as liners or leachate collection systems, to prevent the leakage of liquids from the waste into the environment. Engineered landfills, however, are primarily used for the disposal of hazardous waste and are designed with liners and leachate collection systems to prevent environmental contamination and groundwater pollution. Sanitary landfills are similar to engineered landfills but are intended for the disposal of non-hazardous waste, such as MSW. Most of the landfills in the UAE fall under the categories of traditional or sanitary landfills. The older landfills in the UAE are mostly traditional and lack proper design and engineering features. The UAE government has initiated policies to modernize and upgrade these landfills to improve environmental performance and reduce pollution potential. This may involve

the closure of older landfills and the establishment of advanced landfills that integrate engineering and design elements to better manage waste and protect the environment.

The process of sanitary landfilling in the UAE involves sorting and separating the waste into recyclable materials, organic waste, and non-recyclable waste. The non-recyclable waste is then transported to the landfill site and placed in designated areas, which are covered with soil to minimize the release of pollutants. The waste is compacted daily and covered with soil to control odors and reduce pest attraction. The landfill sites are lined with clay and plastic to prevent leaching of waste materials into groundwater (Aljaradin and Persson, 2015).

The UAE is equipped with modern landfill sites, such as the Al Dhaid landfill in Sharjah, the Al Awir landfill in Dubai, and the Al Ain landfill in Abu Dhabi, which are equipped with state-of-the-art technology to ensure the safe and responsible handling of waste. These facilities have been designed to minimize the environmental impact of waste disposal and protect public health and the environment. However, it is crucial to note that landfilling has several environmental drawbacks, including soil and water pollution, greenhouse gas emissions, and the utilization of valuable land space. Additionally, landfilling is not a sustainable method of waste disposal in the long run, as the landfills will eventually reach capacity and require redevelopment.

2.2 Waste to Energy

Waste-to-Energy (WTE) is an emerging waste disposal method in the UAE, aimed at reducing the amount of waste landfilled, producing clean energy, and reducing the country's reliance on non-renewable energy sources. WTE facilities transform waste into energy through combustion, pyrolysis, and gasification processes (Das, et al., 2022 , Hadjidimoulas, C, 2018, and Paleologos et al,. 2016).

The UAE has several existing WTE facilities, including the Dubai Waste-to-Energy Facility, which was inaugurated in 2018 and is the largest of its kind in the Middle East and North Africa region. The facility has the capability to process 2,000 metric tons of waste per day and utilizes state-of-the-art gasification technology to convert waste into electricity, which is then fed into the grid. Another notable WTE project is the Abu Dhabi Waste Management Center (Tadweer) facility, which began operations in 2019 and has a daily processing capacity of 400 metric tons of waste. This facility employs mass-burn technology to convert waste into energy, which is used to power its operations and produce electricity.

In Sharjah, the Al Saja'a Waste Management Centre, developed by Bee'ah, the Sharjah-based environmental management company, is set to include a WTE facility with a daily processing capacity of 2,500 metric tons of waste and a projected generation of up to 50 MW of electricity. The plant will utilize advanced gasification technology and is expected to become operational by 2024. WTE facilities are constructed to meet international environmental standards and employ state-of-the-art technology to ensure safe and responsible waste handling. Emissions from these facilities are rigorously monitored to maintain compliance with environmental regulations. However, it is worth mentioning that WTE technology is associated with several challenges, such as high capital costs and potential environmental and health impacts associated with emissions.

2.3 Landfill remediation

In the UAE, addressing environmental issues caused by traditional landfills is a key component of the country's waste management strategy. Landfill remediation involves cleaning up and restoring areas used as landfills once they reach the end of their lifespan.

The process of landfill remediation may include capping, covering, and stabilizing the landfill, as well as managing and treating any contaminated water or gas. The specific remediation method will depend on the landfill's conditions, including the type of waste deposited and potential environmental risks. Closed landfills, where solid waste is no longer disposed of but sedimentary waste still remains, require extensive environmental treatment and monitoring before redevelopment.

Bee'ah, an environmental management company in Sharjah, has been transforming landfills into designed landfill cells since 2007. It also regulates air quality by monitoring landfills with advanced drones, and employs gas and leachate pumps and intake wells. The landfill is also made more sustainable by creating drought-resistant green zones, which prevent soil instability, groundwater contamination, and greenhouse gas emissions, using recycled gray water for irrigation. Moreover, Bee'ah plans to transform the Al Saja'a landfill into the first solar energy farm in the area, covering 47 hectares and having a 42-megawatt capacity.

Table 1: The amount of waste generated and the percentage of treatment (non-hazardous waste - solid waste - hazardous waste) in 2016, 2017, and 2018 (Ministry of Climate Change and Environment,2020).

Year	Amount of non-hazardous waste (tons)	Treated non-hazardous waste %	Amount of hazardous waste (tons)	Treated hazardous waste %	Amount of solid waste (tons)	Treated solid waste %
2016	33,084,176	13.45%	226,326	53.17%	6,039,985	22.56%
2017	38,806,236	12.00%	398,901	48.81%	6,182,222	23.82%
2018	34,876,295	17.45%	402,198	85.83%	6,518,006	28.12%

According to the Ministry of Climate Change and Environment's Environmental Status Report 2020, the treatment rate of non-hazardous waste rose from 13% in 2016 to 17% in 2018. Despite this increase, the volume of non-hazardous waste produced remains substantial. The amount of municipal solid waste, on the other hand, grew from 6 million tons in 2016 to 65 million tons in 2018, with the treatment rate also increasing from 22% to 28%. Meanwhile, the volume of hazardous waste saw a dramatic rise, going from 226 thousand tons in 2016 to 400 thousand tons in 2018, with the treatment rate climbing to 86%. The National Bureau of Statistics (NBS) shows that the total amount of waste generated in the UAE has been consistently increasing, with the construction and demolition sector being a significant contributor. The percentage of treated waste varies by Emirates and the type of waste. The UAE has introduced various waste management initiatives to increase the treatment rate, but there is still a need for improvement in the percentage of treated waste and reducing the total amount of waste generated.

2.4 Construction waste

Construction and demolition (C&D) waste, also known as construction waste, is solid waste produced during the building, demolition, refurbishment or destruction of structures. This type of waste can consist of a range of materials including concrete, bricks, wood, metals, and plastics, and can have negative impacts on the environment by taking up valuable land and resources and polluting the environment. There are several successful recycling systems for C&D waste around the world, such as Hong Kong, which implements a fee system for C&D waste and has strict regulations, leading to a decrease in landfill waste disposal by 60%. Another example is Singapore, with a record-high recycling rate of 98% for C&D waste. The UAE is facing a significant challenge in the management of C&D waste due to its rapid urbanization and construction. The rapidly growing construction industry in the UAE has resulted in an increase in the generation of C&D waste (Figure 1). The management of C&D waste in the UAE is regulated by local municipalities, and the waste is managed through the use of recycling facilities. These facilities process C&D waste to recover materials that can be reused or recycled, such as concrete, bricks, wood, metals, and plastics. By diverting these materials from landfills, resources can be conserved and the environmental impact of extracting new materials can be reduced. In 2020, 42,000 tons of construction waste were generated in the UAE, of which 30,000 tons were recycled and around 12,000 tons were disposed of in landfills (Table 2). In addition to regulations, policies are also in place to ensure that construction companies properly manage their C&D waste, including sorting and separating waste materials, proper storage and transportation, compliance with safety and environmental regulations, and the requirement to recycle or reuse a certain percentage of the waste generated. The sand generated from the treatment processes in C&D waste recycling in the UAE is used to cover landfill waste, and four different sizes of gravel are produced for use in infrastructure projects. However, only two companies, Tadweer and Bee'ah, currently recycle this material, limiting their ability to handle all of the state's waste despite the success of the recycling process in reducing waste from construction and demolition activities (Tadweer, 2022).

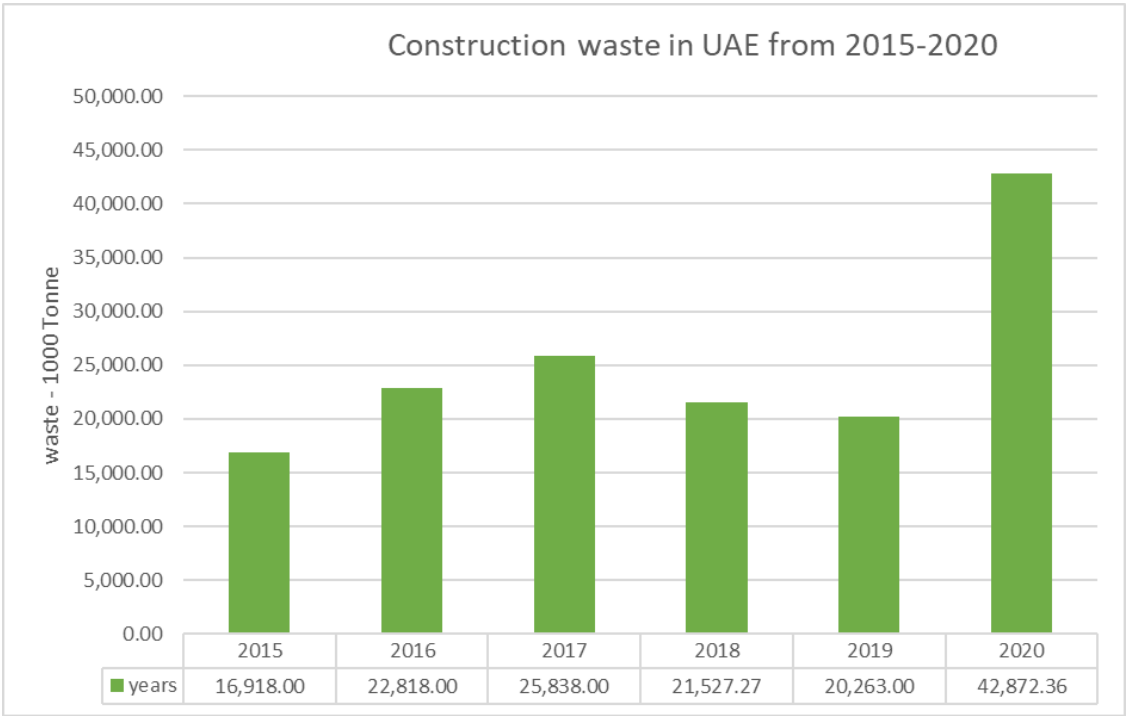

Figure 1: Construction waste in UAE - 2016 to 2020 by 1000 tonnes (NBS,2021).

2.5 Medical waste management

The healthcare industry is vital to the economy, but it also generates a significant amount of waste, known as medical waste. This waste includes sharps, laboratory samples, and unused medications. In the UAE, medical waste is managed by specialist companies with a license from the Ministry of Climate Change and Environment. These companies collect and sort the waste before processing it and disposing of it in an environmentally responsible manner, such as through incineration or landfilling. The Ministry of Climate Change and Environment regulates the disposal of medical waste in the UAE, which is usually treated using heat, chemicals, or incineration in approved facilities. Companies such as Wekaya in Sharjah, Tadweer in Abu Dhabi and Al Ain, and the waste management departments of Dubai and Ajman, as well as RAK Waste Management Agency in Ras Al Khaimah, are responsible for managing medical waste in the country (Wekaya 2022) . In 2020, a total of 23,829 tons of medical waste were generated in the UAE, with 10,421 tons undergoing physiochemical treatment, 31 tons being burned with energy recovery, 11,892 tons being burned without energy recovery, and 1,484 tons being dumped (Table 2) (UAE G 2022). Due to the COVID-19 pandemic, the amount of medical waste generated globally, including in the UAE, has increased, particularly in the form of personal protective equipment such as masks, gloves, gowns, and face shields. To address this issue, the Ministry of Climate Change and Environment in the UAE published Ministerial Resolution No. 228 of 2020, which provides guidelines for safely managing and disposing of biological waste, including infectious waste, during the pandemic. The guidance document includes information on the classification of infectious waste, safe handling procedures, and measures to minimize exposure to pollutants and infectious waste. It prioritizes the treatment and disposal of medical waste generated during the pandemic, ensuring continuous collection and rapid treatment, and starting the operation of a mobile incineration station. According to the NBS in the UAE, the country generated 15,601 tons of medical waste in 2019. However, due to the COVID-19 pandemic, that number rose to 23,829.60 tons in 2020. Abu Dhabi had the highest amount of medical waste generated at 10,041 tons, followed by Dubai with 7,725 tons, Sharjah with 3,417 tons, and Umm Al Quwain with the least amount of 196 tons.

The UAE is ahead of many other countries when it comes to managing medical waste, due to the presence of laws and regulations related to the sector. As per a study by Ian Tiseo (2020), it was found that 43% of the world's countries lack legislation regarding healthcare waste management. The UAE utilizes state-of-the-art technologies and equipment, including specialized transport vehicles and treatment plants, data and reading devices, and a team of highly trained and qualified personnel to manage medical waste. They adhere to strict health and safety guidelines, including frequent worker checks, sterilization of containers, trucks, and sites, and ongoing training and awareness for staff and healthcare institutions. The country is also committed to finding environmentally friendly solutions for waste treatment. Landfills are regularly monitored and inspected to prevent leaks and damage to the environment and are constructed to meet safety standards.

While each Emirate is responsible for managing medical waste within its jurisdiction, there is a need for standardization across organizations and guidelines to ensure the safest methods are being followed. During the COVID-19 pandemic, there was a significant increase in the amount of infected PPE waste, such as masks and gloves, as well as unused medicines and needles used in homes. To reduce the risks associated with medical

waste, the UAE could benefit from the implementation of a mini-system for managing healthcare waste from homes, such as the provision of medical waste containers in residential areas. Additionally, smaller clinics that do not properly segregate waste should be monitored and penalized if they are found to be non-compliant.

Table 2: The waste management process and quantity of waste treated 2020 (NBS,2021).

Process	Quantity by tons
Dumped	1,484
combustion with energy recovery	31
combustion without energy recovery	11,892
Recycling	30,499.32
Landfilling	12,373.04

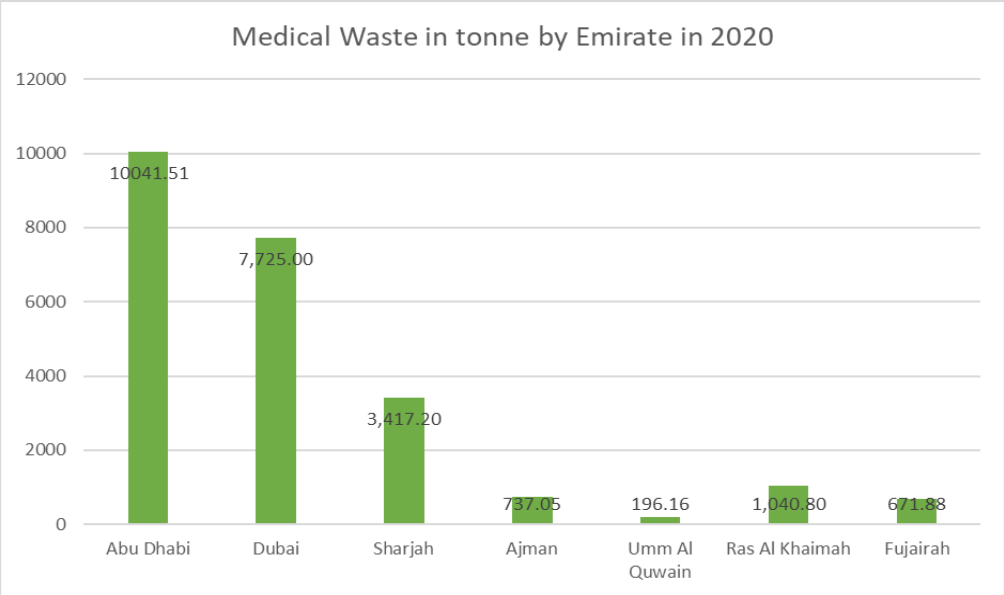

Figure 2: Medical waste in tonne by Emirate in 2020, total amount 23,829,60 tonne (NBS,2021).

3. METHODOLOGY

The study's approach involves a comprehensive analysis of the literature on waste management in the UAE. This includes a review of government policies, regulations, and initiatives related to waste management and an evaluation of the challenges and opportunities for sustainable waste management. The data was gathered from various sources, such as the Ministry of Climate Change and Environment's Environmental Status Report 2020 and the National Bureau of Statistics of the UAE. In addition to this, the researchers held a meeting with the head of the environmental department at the Ajman Municipality. The scope of the study was from 2016 to 2020.

The Al Jurf Landfill in Ajman is the primary waste disposal location for the Emirate since 2006. The landfill, which is operated by the Ajman Municipality and Planning Department, receives and disposes of all types of waste, including municipal, commercial and industrial. On a daily basis, the landfill receives and disposes of approximately 750 tons of waste (Yasser.K, Ajman Municipality). The total amount of waste

disposed of in the landfill amounts to nearly 4 million tons, including the soil used for covering which was 5 million tons (Al-Dabbagh, 2021).

4. DISCUSSION

The waste management process in the Ajman landfill is coordinated with local authorities and is in line with the UAE's KPIs for waste management performance in 2021. The municipality of Ajman Al-Jurf is continuously working to improve waste management by adopting new technologies and processes, such as waste-to-energy, recycling, improved waste separation and collection, and treating wastewater. Their aim is to reduce the per capita environmental impact and pay attention to air quality.

The Al Jurf landfill covers an area of nearly 30 hectares and is divided into two sections. The central section is 600 by 300 meters in size, while the smaller section measures 400 x 300 meters (Figure 3). The landfill is located in the western part of Ajman, along the E11 highway known as Al Ittihad Street. The surrounding area is predominantly commercial space and is known as the Al Jurf Industrial Area. In recent years, the area has seen the development of residential complexes, business areas, schools, cafes, restaurants, and other commercial spaces like warehouses, offices, and shops.

Figure 3: Ajman landfill map, from google map.

Industrial waste and sewage sludge make up a combined 10% of the total waste in the area. According to government data, the sewage sludge ponds are estimated to have a depth of 6 meters and to be capable of holding approximately 125,000 cubic meters of sewage sludge. Household waste accounts for 30% of the total waste. Construction and demolition waste make up a significant portion of the waste, accounting for 60% of the total. Out of this 60%, it is estimated that roughly 50% of the waste consists of raw materials. Sanitary landfills have become a popular and effective method of landfill remediation in modern times (Akpeli 2019). The process of a sanitary landfill involves the layering of compacted waste material, which is then covered with layers of soil. The site is then sealed with a cap once it reaches its full capacity. In addition to providing a solution for waste disposal, sanitary landfills have the potential to generate energy through the collection of landfill gas. This gas

can either be used directly as a fuel source or processed into a more refined fuel. Furthermore, organic materials from the landfill can be separated and used to produce natural gas. Implementing a sanitary landfill in Ajman Jurf would bring numerous benefits to the area. Landfills have been shown to be a largely untapped source of essential metals. By mining landfills for recyclable materials that were once considered garbage, a new source of these products can be created (Aljaradin et al., 2014, Fisher, 1995). The implementation of landfill mining as a solution for excessive waste production has proven to be both economically viable and industrially feasible (Hogland et al., 2004, USEPA, 20022). This process not only provides a solution to the waste disposal problem, but also creates a new source of valuable materials that were previously considered as waste. The proposed methods of Sanitary landfill and landfill mining are highly beneficial from multiple perspectives such as social, economic, and environmental. From a social perspective, the implementation of these methods can bring about a significant reduction in unwanted odors, social disturbances, and the presence of insects and rodents in the area, especially if there is a school nearby. Additionally, these methods can result in aesthetic improvements for the neighborhood, especially if they are covered with vegetation or turned into tourist attractions. Economically, the region can reap numerous benefits from these methods. For instance, converting waste to energy can provide a source of renewable energy and free up space for redevelopment. On the other hand, the mining of recyclable waste such as metals, plastics, and rare earth minerals can generate revenue for the region. Moreover, the covering used for the landfill can be a source of revenue through the attraction of tourism or the generation of energy from solar panels. From an environmental viewpoint, both methods are highly beneficial. The Sanitary landfill system can use greenhouse gas methane as a source of renewable energy and reduce environmental pollution. The Landfill mining process, on the other hand, can encourage the reuse of materials and promote sustainability. This method can also transform the area into a wildlife attraction and be beneficial for the environment of Ajman Jurf. However, both methods face certain challenges that need to be considered before implementation. The first obstacle is the closure of the landfill, as it is the only landfill in the Emirate. The process of Landfill mining is high in cost and requires the excavation, transportation, and sorting of the waste. It also results in the emission of hazards and annoyances such as odors, potential fires, and problems for the community. Moreover, not all waste can be recycled due to the conditions in which it is stored, and the process can take several years to complete. On the other hand, while Sanitary landfill costs are lower than Landfill mining, proper construction is necessary to prevent hazardous materials from seeping into the surrounding area. The Ajman landfill is old and poorly constructed, making it difficult to prevent material leakage. The hot weather and soil conditions in the area also pose challenges for covering the landfill, and the placement of vegetation cover can put pressure on water consumption.

The remediation of the landfill in Ajman Al Jurf is crucial to improve the environment for the local residents and bring benefits in terms of economics, social, and environment. However, this process requires financial support and can be accomplished through various methods. For instance, the use of vegetation in the landfill area to increase its fertility levels, or the conversion of the methane gas from the landfill into a source of energy (Hogland, w., 2002 and Camerini, G 2014).

To further mitigate the waste problem in Ajman Al Jurf, the residents should reduce their waste production, and the local government should implement awareness programs to educate the community. Additionally, the landfill can be closed, and the waste can be transported to other nearby lands with the cooperation of other

companies such as Bee'ah or other municipalities like Umm Al Quwain. Currently, only 40% of the treated wastewater in Ajman is utilized, with the rest being disposed of into the sea (Kayed, 2022). One solution to this problem is to turn the landfill into an artificial lake, which can attract wildlife and improve the treatment of wastewater. Once the landfill has been remediated, the land can be used for various purposes such as commercial development, or the installation of solar panels to generate renewable energy and reduce energy consumption and pollution in the region. The land can also be split into multiple sections, serving as a landmark for the emirate, while also providing clean energy through solar panels.

5. CONCLUSION AND RECOMMENDATION

One major challenge is the need for more infrastructure and resources to collect and dispose of waste properly. The country lacks an adequate number of landfills and incineration plants, and the existing facilities are often located in remote areas that are difficult to access. This has led to illegal dumping and the proliferation of informal waste pickers, often exposed to hazardous materials and working in dangerous conditions.

The remediation of the landfill in Ajman Al Jurf is important for the improvement of the environment and to bring benefits in terms of economics, social, and environment. Sanitary landfills and Landfill mining are proposed as methods to remedy the landfill and provide numerous benefits such as reduction of odors, social disturbances, and insect presence, generating revenue, providing renewable energy, and promoting sustainability. However, both methods face challenges in terms of costs, hazardous material leakage, and the duration of the process.

The local government and residents of Ajman Al Jurf should work together to mitigate the waste problem. This can be done through reducing waste production, implementing awareness programs, and seeking financial support. The landfill can be remediated through methods such as the conversion of methane gas into energy, the use of vegetation to increase fertility levels, or the closure of the landfill and transport of waste to other nearby lands. Once the landfill has been remediated, the land can be used for various purposes such as commercial development or the installation of solar panels to generate renewable energy.

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