

Food Waste Management System in Saudi Arabia

Abstract

Food waste (FW) remains one of the most challenging issues that Saudi Arabia is currently facing. Research shows that the country is struggling with ensuring sustainable solutions, due to lack of the current food waste management process to handle the increase of FW volume in the future. Food waste management is a significant research area that has dramatically grown over the years, but little research has been done on sustainable food waste management. This paper focuses on analyzing existing practices of food waste management and sustainable approaches that can be used in the future. This literature stands in the gap by presenting new perspectives that have to identify the proper strategies within the context of Saudi Arabia. This review aims to develop the food waste management system in Saudi Arabia to accomplish sustainable results for its environment. The different significant approaches are food waste management hierarchy, waste to energy technology, and composting technique. Also, the paper explores case studies that address this issue by promoting sustainable approaches based on collected data. However, a number of gaps have been revealed, including the economic benefits, the impact of each approach on the overall management process, and the need for establishing an integrated system.

Introduction

Food waste (FW) exponential increase is posing a risk to the sustainability of the existing food waste management system in Saudi Arabia. The country has the highest level of wasted food internationally, where the food waste accounts for half of the municipal solid waste annually in major cities (El Bilali & Ben Hassen 2020). Moreover, more than a third of the food that is grown for consumption ends up in the dumping site untreated. As there are different factors associated with the rise of wasted food; however, the inadequate FW management system has led to more environmental and economic difficulties. The landfilling technique is the typical FW management process in the country. Although this technique does not involve complex implementations, it made the country struggling with ensuring a sustainable food waste management system. Fundamental investigation research done by Al-Zahrani, Baig & Straquadine (2018) has outlined the implications and the lack of the current FW management system in handling the expecting increase of the generation of FW in the future. Also, the researchers indicated that there is an urgent need to take appropriate measurements by the policymakers in the country. According to Oelofse et al. (2020), since food waste is a severe issue in KSA, the Saudi Arabian government recently launched a new policy of vision 2030 that aims at embracing sustainable solutions for the management of food waste in that country. Nevertheless, there is a weak implementation of this policy. Despite the value of the topic, limited researches have been done in the potential sustainable approaches in Saudi Arabia. This review will focus on the different possible approaches presented in the food waste management context related to Saudi Arabia. The aim is to enhance the current process to achieve more sustainable outcomes for the Saudi's environment.

Literature Review

Mu'azu et al. (2019) noted that minimizing food waste is a crucial sustainability challenge for the Kingdom of Saudi Arabia and something that requires adequate attention. Although food waste is a global issue, addressing it has not been possible due to factors such as cultural attitudes, working conditions, education attainment, as well as due to differences in religious practices. They claimed that the key factors hindering food waste management in Saudi Arabia include lack of systems that can be used in collecting and reusing used food and inadequate information concerning the amount of food being wasted. From the study, Mu'azu et al. (2019) found that currently, Saudi Arabia does not have any operational guidelines concerning the issue of food waste management. Thus, efforts towards food waste management such as recycling and reuse are carried out by

informational campaigns. The researchers, therefore, posit that the country should adopt long-term approaches as landfilling is not adequately engineered. As a result, a food waste management hierarchy was proposed. This pyramid is prioritizing and identifying management options by considering the sustainability dimensions. Despite that, the proposed hierarchy similar to the USA Food Recovery Hierarchy it accounts for the cultural practices of the people of Saudi Arabia and their socioeconomic characteristics. The reuse and recycling concept, including compost technique, energy recovery plant, and incineration, were presented as management options. From the hierarchy, the researchers discussed the respective aspects such as status, challenges, and recommendations to all the least preferable options and preferable options. For the composting technique, it is currently existing but not fully practiced as the challenge is the public and industrial acknowledgment of the value of FW separation. So, the recommendation provided is the enactment of new policies to support segregation practices. The energy recovery plant is not existing, as the challenge faced is the inadequate technical knowledge. Therefore, they recommended incentive policies to organizations by the government to encourage research and development activities. The incineration method is used for other solid waste but not for food waste in the country, and the major challenge is the rise in the energy cost of the facility. The recommended action is strategic planning with quality policies to ensure sustained implementation. In order to ensure sustainable food waste management, the research concluded that such an approach should incorporate both Saudi's current practices and the suggested future management approaches.

Anjum et al. (2016) evaluated the contribution of converting food waste into energy in managing the FWM in Saudi Arabia. The environmental impact and the issues related to the current system were addressed briefly. The focus of this research was to identify the modern technologies available today as a new shift to manage uncontrolled dumping practices. Anaerobic digestion and fermentation waste to energy (WTE) technologies were proposed as the most sustainable approaches based on the food waste volume and the forecasted energy demand in Saudi Arabia. Further, they suggested a block diagram that clarifies how each technology operates to ensure the full benefits of the biogas in managing food waste. The conclusion was drawn that enhancing the current strategic planning is a need to develop the food waste management system effectively. Also, this new shift will add value to the energy demand and the economy in Saudi Arabia. Similarly, another research was conducted by Baig, Mirza Barjees, Gorski & Neff (2019) did emphasize the importance of using waste to energy technologies in improving food waste management in the country. The research recommended that adopting this new technique should be done by using better data collection analysis. Demirbas et al. (2016) highlighted the effectiveness and the sustainability of small-scale biomass facilities to generate renewable energy to housing units in the residential areas across the kingdom. The study was aimed to identify the potential of waste to energy concepts in managing food waste. A system was proposed based on hypothetical calculations of the population size, the volume of food waste, the size of the residential area, and the average energy demand and usage. Moreover, the design system concept is to first establish a collection system of food waste in the residential area, building the biomass facility, and extended power network to supply the housing units. The research findings showed that around 2% of the demand energy could be generated by the conversion of food waste into renewable energy for housing utilization. The proposed framework presents an opportunity to manage food waste efficiently. However, these findings are appeared to still build upon a theoretical framework.

Baig, Mirza B. et al. (2019) discussed the development of composting facilities at the household level in the communities as a feasible solution to enhance FW management. The researchers noted that the core reason why the current FW management system is still practicing in the country is the difficulty of finding competent labor to convert to more advanced technologies. Therefore, the research explained the basic process of the operation, which involves: sorting and separating the food waste done by the household owners, a bin storage and collection location established and managed by the Municipalities, and composting bins where the FW been decomposed into soil fertilizer. The research concluded that this method would be more economical compared to the landfilling process. However, it can be argued that the "household level" application is limited as a lack

of awareness of the community to the need for a more sustainable FW management system is one of the significant challenges. This supported by Radwan & Mangi (2019), who elaborated that long-term utilization of the composting method is the practical use of the existing facilities in the country. The researchers elaborated that composite facilities play a valuable technique due to its cost-effectiveness and environmentally friendly. Despite the role that facilities play, it affected by factors such as bad odor, electrical conductivity, high contents of moisture, and reduced nutritive value. The research also examined the challenges experienced in Saudi Arabian's composite facilities. It aimed to optimize the composting methods through the use of local natural zeolite and biochar that has been manufactured locally while assessing the benefits of an improved food waste composting. These are capable of enhancing the rate of degradation. The research concluded that shifting from landfilling to composting facilities will add value to the agriculture industry, thus to the Saudi economy.

Hariri, Abdelmagid, and Faris (2014) demonstrated the scheme of a zero-waste community concerning food waste management. The study did explore the significance of the formulation of regulation to ensure the practical utilization of the 3Rs concepts: Reduce, Reuse, and Recycle. Also, the research referred to a similar initiation done by the Scottish government in 2012 as a typical model that successfully supported the sustainability of the food waste management system. Therefore, the researchers presented a zero-waste plan in the context of Saudi Arabian communities. This plan is consisting of closed-loop applications that represent the Saudi government, the 3Rs operations, and related stakeholders (manufacturers and residents) while the food waste management system will priorities the preferred outcomes. As the argument is convincing, however, this might require a continuous emphasis by the government as it depends on the high participation of the different stakeholders.

A study conducted by Hakami & Seif (2015) examined the issue of the current process of food waste management system "landfilling" in Jeddah city. The study aimed to establish a base for the decision-makers to determine the suitable food waste management methods. It selected the city of Jeddah as a planning model using a quantitative methodology where the city was divided into four regions. Four hundred samples of solid waste were collected from 60 dumping sites randomly. The study found that food waste represents the majority of waste in the city, and the current landfilling sites will not be capable of handling the increase in the future. Therefore, the researchers discussed that to identify suitable management alternatives, risk control and assessment is crucial. The risk mechanisms will be determined using statistical studies in which it will establish a foundation for providing a structured risk management plan. This will present a contribution in selecting the appropriate food waste management strategy, including basic elements such as resource availability, key stakeholders, cost allocations.

Research Gaps & Questions

- The economic benefits of each approach have not been clarified.
- The significance of waste to energy approach has to be adequately studied.
- The impact of each approach or technology on the overall management process has to be addressed.
- It would be necessary to have an integrated system.

The related questions:

- How much will each approach cost, and how much will it add to the Saudi economy? How cost-benefit analysis will determine the alternative approach to improve
- Which WTE technology is appropriate to use in Saudi in terms of cost, labor requirements, location, and infrastructure? How much renewable energy it will generate to meet future demand?
- By how much is the proportion of these approaches will improve the overall management process?
- What is the execution process and the system functional design in the V-model representation?

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