Abdullah Alahmary

Assessing the Economic Viability and Sustainability of Municipal Solid Waste Management Strategies in Riyadh, Saudi Arabia

Keywords: economic cost; sustainability; waste to energy; recycling; incineration

The rapid urban expansion and population growth in Riyadh, Saudi Arabia, have intensified the generation of municipal solid waste (MSW), posing significant challenges for effective waste management. This research explores the **economic viability and sustainability** of various MSW management strategies, employing **Life Cycle Assessment (LCA)** and **Life Cycle Costing (LCC)** methodologies. These methods provide a comprehensive framework for evaluating the environmental and economic performance of different waste management systems, including landfilling, recycling, composting, and waste-to-energy (WTE) technologies.The **LCA approach** is utilized to quantify the environmental impacts of each waste management strategy, focusing on metrics such as greenhouse gas (GHG) emissions, energy consumption, resource depletion, and pollution levels across the entire life cycle—from waste collection and transportation to treatment and final disposal. Simultaneously, the **LCC analysis** evaluates the financial implications of these strategies, considering capital investment, operational and maintenance costs, and potential revenue streams from resource recovery (e.g., recycling materials or energy generation). Integrating these methods allows for a holistic assessment of the trade-offs between environmental performance and economic feasibility.Preliminary results indicate that **waste-to-energy (WTE)** and **enhanced recycling systems** outperform traditional landfilling in terms of both environmental sustainability and long-term economic benefits. WTE technologies, despite high initial investment costs, offer significant reductions in GHG emissions and provide a renewable energy source, contributing to Saudi Arabia's Vision 2030 goals for sustainability and energy diversification. Recycling systems demonstrate potential for economic revenue through material recovery, though challenges such as low public participation rates and the lack of efficient waste segregation infrastructure must be addressed. The analysis also highlights the limitations of landfilling, including its significant environmental footprint and diminishing economic feasibility due to increasing land scarcity and regulatory pressures.This study provides actionable insights for policymakers, urban planners, and environmental stakeholders in Riyadh, emphasizing the importance of adopting an integrated waste management approach that aligns economic and environmental priorities. By leveraging LCA and LCC methodologies, the research delivers a robust framework for evaluating and

implementing sustainable MSW strategies, with implications for transitioning Riyadh toward a **circular economy model**. These findings contribute to the broader discourse on sustainable urban development and resource management in the Gulf region.

Municipal solid waste (MSW) management is a critical challenge for rapidly growing urban centers, particularly in cities like Riyadh, Saudi Arabia, where population growth and urbanization have significantly increased waste generation. This study evaluates the **economic viability and sustainability** of current and proposed MSW management strategies in Riyadh, aiming to provide actionable insights into optimizing resource efficiency and minimizing environmental impacts.Using a combination of **quantitative cost-benefit analysis** and **qualitative sustainability assessments**, the research examines key waste management practices, including landfilling, recycling, waste-to-energy conversion, and composting. The study emphasizes the importance of an integrated approach that balances economic considerations with environmental and social sustainability. Critical factors such as operational costs, greenhouse gas emissions, job creation potential, and public health implications are analyzed to determine the most effective pathways for managing municipal waste in the context of Saudi Arabia's Vision 2030 sustainability goals.Preliminary findings highlight that recycling and waste-to-energy solutions offer significant potential for reducing landfill dependency while generating economic value. However, these strategies face challenges, including high initial implementation costs, public awareness gaps, and the need for robust policy frameworks to incentivize participation from stakeholders.The research contributes to the growing body of knowledge on sustainable urban development and waste management in the Gulf region, offering a comprehensive assessment that can guide policymakers, urban planners, and environmental agencies in Riyadh. By addressing the economic and environmental trade-offs of various strategies, this study aims to support the city's transition toward a more **sustainable, circular economy**.