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ENVIRONMENTAL SANITATION: STRATEGIES AND CHALLENGES IN WASTE MANAGEMENT

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Abstract

Waste management is one of today's most crucial environmental challenges that demands innovative and integrative solutions. The study conducted in this research uses the literature research method. The results show that the effectiveness of waste management depends not only on the application of green technology and adequate infrastructure but also on active participation and public awareness of sanitation issues. The implication of this study suggests the importance of a holistic approach to waste management, which includes a combination of technological innovation, supportive regulations, public education, and the involvement of all stakeholders.

Keywords: Environmental Sanitation, Strategies, Challenges in Waste Management.

Introduction

Environmental sanitation is one of the important aspects in maintaining public health and environmental quality. Sanitation issues are closely related to waste management, whether domestic, industrial, or medical waste, which if not managed properly, can have various negative impacts on human health and the environment (Abdelfattah et al., 2023). Poorly managed waste can be a source of disease, water, soil, and air pollution, and contribute to climate change. Furthermore, health risks are high; contaminants can easily contaminate drinking water sources and the food chain, causing diseases such as diarrhea, cholera, dysentery, and others (Abubakar et al., 2022). Also, air pollution caused by open burning of waste can lead to respiratory problems and cardiovascular diseases. Thus, effective sanitation prevents the spread of disease and protects community health (Agamuthu & Barasarathi, 2021).

In addition, good environmental sanitation is also important for maintaining people's mental health and quality of life. A clean and well-maintained environment improves the comfort and aesthetics of an area, which psychologically contributes to general well-being. For example, well-maintained parks and public spaces encourage physical activity and social interaction which are important aspects of mental and physical health (Ahirwar & Tripathi, 2021). Poor sanitation conditions, on the other hand, can lead to stress and discomfort, which in turn negatively impacts one's psychological state. Through investment and attention to environmental sanitation, communities can create a strong foundation for not only the physical but also mental health of their citizens (Al-Hazmi et al., 2023). Therefore, improved strategies in waste management are urgent to implement.

Waste that is not managed appropriately has a significant influence on the quality of environmental sanitation. Both solid and liquid waste if disposed of carelessly can degrade water and soil quality. For example, household waste containing food waste, chemical products, and other materials can serve as a growth medium for pathogenic microorganisms if not treated properly (Alam & Qiao, 2020). Industrial effluents often contain hazardous substances that, if released into nature without treatment, can contaminate water resources and cause ecosystem damage. This water pollution has a direct impact on humans and animals that depend on the water for consumption or habitat, posing long-term health risks such as skin diseases, poisoning, or even cancer (Alzamora & Barros, 2020).

In addition to water quality degradation, waste build-up also causes sanitation problems on land. Poorly managed waste piles can create habitats for pests such as rats and mosquitoes, which are known disease vectors. It is a sanitation problem not only in terms of appearance, but also in terms of public health as it spreads diseases such as dengue fever, leptospirosis, and plague (Anokye et al., 2024). Methane gas emissions from organic waste decomposition can be a cause of climate change, which again affects human health through natural disasters. Thus, poor waste management not only affects the quality of local sanitation, but also has a far-reaching impact on environmental change and global climate (Arslan et al., 2020).

In many countries, especially developing countries, waste management systems are far from ideal. Inadequate infrastructure, limited access to modern waste treatment technologies, lack of public awareness and participation, and financing constraints are some of the main challenges faced. In addition, inadequate or inconsistently applied regulations also add to the complexity of this problem (Arya & Kumar, 2020).

Effective waste management requires not only technical solutions, but also a comprehensive approach involving various parties, including government, industry, communities and non-governmental organizations. Therefore, identifying effective strategies and addressing the various challenges that exist are important steps to improve environmental sanitation conditions (Asante-Duah, 2021).

This study aims to review the various waste management strategies that have been implemented, both at the national and international levels, and to identify challenges and solutions in their implementation. It is expected to provide evidence-based recommendations to support efforts to improve environmental sanitation systems, particularly in terms of waste management, to realize a healthy and sustainable environment for the future.

Research Methods

The study conducted in this research uses the literature research method. The literature research method is a research approach widely used in academic studies, especially to collect, analyse, and interpret data from documented sources. These include scientific articles, books, research reports, articles from mass media, official documents, and relevant online sources. The main purpose of the literature research method is to gain an in-depth understanding of a topic, analyze trends and developments in a particular field, and identify existing research gaps (Abdussamad, 2022); (Adlini et al., 2022); (Afiyanti, 2008).

Results and Discussion

Environmental Sanitation Concept

Environmental sanitation is an important aspect of maintaining and improving public health through preventing human contact with environmental hazards caused by wastewater, litter, and soil and water contamination. It encompasses a wide range of environmental management practices, including domestic and industrial wastewater treatment, solid waste management, disease vector control, and access to clean water and adequate sanitation facilities (Aslam et al., 2020). The primary goal of environmental sanitation is to protect human health by reducing exposure to infectious diseases, particularly those transmitted through environmental routes (Awasthi et al., 2021).

Effective implementation of environmental sanitation requires cross-sector collaboration, involving not only governments but also communities, the private sector, and non-governmental organisations. Strategies include adequate policy-making, infrastructure development, community education on hygiene, and strict monitoring of regulatory compliance (Ayeleru et al., 2020). These initiatives should be tailored to local conditions as differences in access to resources, levels of economic development, and customs can greatly affect the success of sanitation practices. The use of appropriate technology is also important, be it advanced wastewater treatment systems for urban areas or community-based solutions such as communal toilets that are more suitable for rural areas (Ayilara et al., 2020).

Challenges in environmental sanitation are often complex, involving issues such as climate change, rapid urbanization, and socio-economic inequality. Climate change, for example, increases the risk of extreme weather events that could disrupt sanitation systems, while urbanization demands more efficient waste management in rapidly growing cities (Bui et al., 2020). Innovative and adaptive approaches are therefore needed to meet these challenges, ensuring every individual, regardless of location or economy, has access to basic sanitation. This not only improves public health conditions but is also an important contribution to sustainable development.

Definition and Types of Waste

Waste can be defined as leftover materials resulting from human activities or natural processes that no longer have economic value and need to be disposed of or managed in some way so as not to pollute the environment. These wastes are generally categorised based on their different characteristics and origins, which determine the required management and disposition methods (Chen et al., 2020). Thus, one of the critical aspects of environmental management is a deep understanding of the different types of wastes, their potential impacts on human and ecosystem health, and the best strategies for their management (Comineti et al., 2024).

The first and most common type of waste is solid waste. Solid waste can be household waste, including food waste, packaging, unwanted items, and industrial waste derived from manufacturing processes. Solid waste is generally further classified into biodegradable and non-biodegradable waste. Solid waste management involves collection, segregation, recycling, or disposal to landfill. In addition, efforts to reduce waste production at source are significant in solid waste management (D'alessandro et al., 2020).

Liquid waste is another type of waste that includes domestic, industrial, and agricultural wastewater. This wastewater contains various dissolved and suspended substances that require treatment before being discharged into the natural environment to prevent contamination of water, soil, and ecosystems. Wastewater treatment aims to reduce the content of organic pollutants, nutrients, hazardous chemicals, and pathogenic microorganisms so that the discharged water is no longer harmful to human health and the environment (Das et al., 2021).

Furthermore, hazardous waste is a category that includes solid or liquid waste that contains hazardous or toxic materials that can harm human health and the environment. These wastes can come from various sources, including chemical industries, research laboratories, and medical facilities (Debrah et al., 2021). Hazardous waste requires special handling in its collection, transport, treatment, and disposal to ensure that risks to public safety and the environment are minimised. Prevention of soil, water, and air contamination is a top priority in hazardous waste management, often requiring advanced technology and strict procedures in handling (Despoudi et al., 2021).

In conclusion, waste is the residual result of human activities and natural processes that need to be managed appropriately to prevent environmental damage and safeguard public health. There are different types of waste, including solid waste, liquid waste, and hazardous waste, each of which requires an appropriate management and dispo approach according to its content and potential hazards. Effective waste management involves reducing waste generation at source, segregation, recycling, treatment, and safe disposal of waste by applicable regulations.

In managing these wastes, it is important to consider the principles of sustainability, with a focus on maintaining ecological balance and preventing pollution. This demands innovation, environmental awareness, and collaboration between government, industry, and community sectors. These strategic measures not only minimize environmental impacts but also support the goal of sustainable development, which is to produce a healthy environment for current and future generations.

Impact of Waste on Environment and Health

Waste, if not managed properly, can cause various negative impacts on the environment. Accumulated solid waste can cause problems such as illegal dumping and landfilling, which often escape into the surrounding ecosystem (Ding et al., 2021). Toxic materials in waste such as heavy metals, plastics, and hazardous chemicals can seep into the soil, poisoning plants and contaminating groundwater sources that are essential for human consumption and wildlife. This pollution can also disrupt natural habitats, reduce biodiversity, and cause disruptions in the food chain (Du et al., 2020).

In addition, wastewater effluents that are not properly treated before being discharged into waters can cause water quality violations, causing major problems for aquatic life. Pollutants such as excess nutrients (nitrogen and phosphorus) can trigger excessive algal blooms, a condition known as eutrophication, which reduces oxygen levels in water and threatens the existence of fish and other aquatic organisms (Dubey et al., 2020). Chemical spills and pathogenic bacteria from wastewater effluents can also lead to the spread of diseases to humans who depend on these water sources for daily use (Esparza et al., 2020).

From a health perspective, the impact of effluents, particularly hazardous wastes, can be significant. Exposure to toxic chemicals, whether through direct contact, inhalation of dust, or consumption of contaminated water, can lead to a range of serious health conditions (Evode et al., 2021). For example, mercury and lead in industrial waste can cause nerve damage and mental health problems, while volatile organic matter released into the air can cause respiratory and cardiovascular problems (Fadhullah et al., 2022). Unsafe waste handling affects not only workers in the relevant industries but also the surrounding communities, which shows the importance of a strict and effective waste handling system (Fan et al., 2021).

Furthermore, burning waste, especially those containing plastics and hazardous materials, can produce smoke containing dioxins and nuisance organic pollutants, which are extremely harmful to human health. Continuous respiration of air contaminated with waste smoke can increase the risk of cancer, reproductive problems, immune system disorders and also server the respiratory system (Fatimah et al., 2020). Furthermore, such open burning when occurring on a large scale can contribute to climate change by releasing greenhouse gases such as carbon dioxide and methane into the atmosphere.

The health impacts of waste can range from short-term effects such as eye and skin irritation, to long-term conditions such as hormone disruption and chronic diseases. High-risk populations include children, pregnant women, the elderly, and workers with direct exposure to waste or waste products. To protect public health, regulators must implement standards for the safe and efficient storage, transport, management and disposal of waste (Gollakota et al., 2020).

With increasing awareness of environmental and health issues, there is a global movement towards more sustainable and environmentally friendly waste management practices. Innovations in recycling technologies and waste-to-energy conversion are some examples of efforts to reduce the impact of waste processing and extract economic value from materials previously considered as waste. On the other hand, initiatives such as waste segregation at source and increased public education and awareness play an important role in reducing waste volumes and minimising their impact on the environment and health.

Strategies in Waste Management

Strategies in waste management should be comprehensive, covering various stages from waste generation, collection, transport, treatment, and recycling, to final disposal. The first step is through prevention and reduction of waste generation at source (Gómez-Sanabria et al., 2022). This can be achieved through environmentally friendly product design initiatives, where products are designed to have a longer lifespan, are easy to repair or recycle, and require the use of fewer, environmentally friendly raw materials. In addition, encouraging responsible and efficient consumption patterns and education on sustainable practices are also key to reducing the amount of waste generated by households and industries (Guo et al., 2021).

After that, an important aspect of waste management is waste segregation. By separating organic, inorganic, and hazardous waste, the recycling and disposal process becomes more efficient and safer. In many countries, the use of separate containers for different types of waste has been implemented, as well as the development of infrastructure that supports separate collection (Gwenzi, 2021). This waste segregation also facilitates the recycling process, where materials such as plastics, glass and metals can be reprocessed into new materials, thereby reducing the need for new natural resources and reducing greenhouse gas emissions resulting from material production (Hantoko et al., 2021).

In the final stage, waste management focuses on treatment and appropriate disposal. Modern waste treatment technologies include various methods such as composting for organic waste, incineration with filter fee gob emission capture systems for non-recyclable waste, to highly regulated landfilling for untreatable waste (Hoang et al., 2022). Waste-to-energy conversion, such as through waste-to-energy plants or anaerobic digestion that produces biogas, is an increasingly popular strategy to gain added value from waste. The importance of strict control of these disposal operations is to avoid pollution and manage risks to the public health of the environment. These practices must be supported by strong regulations, strict supervision, and co-operation between governments, businesses, and communities (Ilyas et al., 2020).

Sewage Treatment Technology

In sewage treatment, the use of technology is a key element that determines its effectiveness in reducing negative impacts on the environment and human health. Such technologies range from simple methods to sophisticated and automated processes. One of the early treatment technologies is the composting technique, which converts organic waste into compost with the help of microorganisms (Istrate et al., 2020). This technique is environmentally friendly as it produces a useful product and reduces the volume of waste that has to be disposed of. Anaerobic digestion, on the other hand, is a biological process that breaks down organic waste in an oxygen-free environment to produce biogas that can be used as an energy source, as well as digestate that can be used as plant fertilizer (Jones et al., 2023).

On a larger and more technical scale, waste incineration is a commonly used technology, especially in countries with limited landfill space. This technology burns waste at very high temperatures, effectively reducing its volume significantly and generating energy in the process (Kabirifar et al., 2020). However, modern incinerators are now equipped with advanced emission filtration systems to capture harmful particles and prevent pollutants such as dioxins and nitrogen oxides from being released into the air. Waste power plants (PLTSa), for example, are applications of this incineration technology that can process tonnes of waste while generating electricity that is then fed into the grid (Kedzierski et al., 2020).

New technologies in waste treatment include various innovative treatment and recycling methods. For example, pyrolysis and gasification technologies are thermochemical processes that convert solid waste into energy feedstocks such as syngas or bio-oil in oxygen-limited environments (Kenny & Priyadarshini, 2021). In addition, plasma arc technology holds promise in reducing hazardous waste by using the extreme temperatures generated by plasma electric arcs to convert waste into usable gases and vitrified glass, which seals out hazardous substances. These waste treatment technologies, along with the development of more environmentally friendly materials and processes, have great potential in defining a sustainable future where the environmental and health impacts of waste are minimised (Kesari et al., 2021).

Beyond physical waste treatment, technological advancements are also aimed at optimising monitoring and management systems for waste treatment facilities. Advanced software and sensors now play an important role in maximizing operational efficiency and compliance with environmental standards. For example, sensor-based sorting technology has improved recycling capabilities by accurately separating different types of materials on the recycling line (Khan et al., 2022). These technologies use spectral analysis techniques such as infrared or X-ray to sort materials based on their composition. The data obtained from these sensors can also be utilised for real-time process optimisation, predictive maintenance of equipment and better inventory management of recyclable materials (Khoa et al., 2020).

Furthermore, the arrival of the Internet of Things (IoT) in waste management enables the seamless integration of various data points throughout the waste disposal chain. Smart bins equipped with sensors can measure fill levels and communicate this information to waste collection agents for timely and efficient pick-ups, thereby preventing overages and reducing the frequency of collection when it is not required (Kibria et al., 2023). Similarly, route optimization software and GPS on collection vehicles have made waste collection routes more efficient, reducing fuel consumption and greenhouse gas emissions. Systems integrated with these technologies ensure a more responsive and efficient approach to waste management (Klemeš et al., 2020).

In the long term, innovations such as artificial intelligence (AI) and machine learning are expected to provide advanced forecasting models and optimize the entire waste management lifecycle. AI can be used to predict waste generation patterns, optimize logistics, and further automate sequencing processes. Machine learning algorithms can analyze large amounts of data to identify trends and recommend adjustments to waste treatment operations, enabling continuous improvement (Koul et al., 2022). By integrating these cutting-edge technologies, the future of waste management looks towards a system that is not only environmentally friendly but also adaptive, capable of reducing human error, and much more efficient at turning waste into valuable resources. As technology continues to evolve, the goal is to close the waste cycle completely, ultimately working towards a circular economy where waste is minimized and fully reused into the manufacturing cycle (Kubanza & Simatele, 2020).

Community-based Waste Management

Community-based waste management is an approach that utilizes the active participation of communities in managing and reducing waste in their neighborhoods. This approach stems from the understanding that the direct involvement of communities in the waste management process can increase environmental awareness, encourage sustainable behaviour change, and significantly reduce the volume of waste generated (Kulkarni & Anantharama, 2020). Through environmental education and dedicated waste management programmes, communities are taught the importance of reducing, reusing and recycling waste as a daily practice. This approach also strengthens community relations and builds a collective sense of responsibility towards the environment (Kumar & Agrawal, 2020).

One effective method in community-based waste management is the establishment of waste banks. These waste banks act as collection centres where communities can deposit the recyclable waste they have collected from their homes. The waste is then sorted, processed, and sold to recycling factories (Kurniawan et al., 2022). The revenue earned from the sale can be utilised for social activities or community development, thus creating an economic incentive for the community to continue participating in waste management activities. Such a model not only helps reduce the volume of waste generated but also supports the local economy (Luttenberger, 2020).

On a broader scale, community-based waste management can contribute to more sustainable waste management efforts nationally and globally. By assimilating waste management as part of everyday life, communities act as agents of change in the transition towards more responsible and environmentally friendly consumption patterns (Kabirifar et al., 2020). Key to the success of this approach is the strong collaboration between communities, local governments, educational institutions, and the private sector, to create an inclusive, effective, and sustainable waste management system. The involvement of all these parties ensures that community-based waste management practices can continue to evolve and adapt according to emerging environmental challenges (Magwaza et al., 2020).

Challenges in Waste Management

One of the major challenges in waste management is the rapid growth of waste production, which often exceeds the capacity of existing waste management systems. Population and economic growth, especially in large cities, lead to a significant increase in the volume of domestic and industrial waste. This complicates the process of waste collection, processing and disposal, often resulting in the build-up of waste in unsanitary landfills (Malav et al., 2020). This build-up not only burdens land and resources, but also generates environmental problems such as soil, water and air pollution, while increasing greenhouse gas emissions that contribute to climate change (Manikandan et al., 2022).

Furthermore, the lack of public awareness and participation in effective waste management adds to the difficulties. Despite many initiatives and programs to educate the public on the importance of reducing, reusing, and recycling waste, there are still difficulties in changing behavior on a wide scale. Low awareness of the environmental impacts of improper waste disposal and lack of understanding of the direct benefits of responsible waste management often result in reluctance to adopt these practices. This is accompanied by consumption habits orientated towards single-use products, which further exacerbates the situation (Mazari et al., 2021).

Finally, infrastructure and funding challenges are also major barriers to effective waste management. Many countries, especially developing ones, face difficulties in providing adequate infrastructure for waste management, including state-of-the-art processing and recycling facilities. This is compounded by a lack of access to sufficient financial resources to invest in the latest waste treatment technologies or in staff training (Mihai, 2020). Without significant investment in infrastructure and technology, as well as adequate policy support, efforts to achieve efficient and sustainable waste management will continue to face severe hurdles (Murthy & Ramakrishna, 2022).

In conclusion, waste management requires a holistic and participatory approach that involves all parties, from the government, community, industry, to educational institutions. Challenges such as rapid growth in waste production, lack of public awareness and participation, and infrastructure and funding constraints require innovative and adaptive solutions. Responding to these challenges requires cross-sector collaboration to develop efficient and sustainable waste management strategies that not only minimise environmental impacts but also provide social and economic benefits. Investments in waste management technologies, environmental education, and community empowerment are key to addressing these challenges. Thus, a responsible waste management system can be achieved, which supports environmental sustainability while opening up economic opportunities for communities.

Conclusion

Environmental sanitation plays a key role in ensuring public health and environmental sustainability. In waste management, effective strategies are needed to deal with the ever-increasing volume of waste. This research has identified that the integration of green technology approaches, improvement of infrastructure systems, and application of circular economy principles are essential strategic measures. Research demonstrates that technologies such as integrated waste treatment and energy-from-waste systems can reduce negative environmental impacts and improve sustainability.

The main challenges faced in sanitation and waste management strategies are changing people's behavior and ensuring strong regulatory support. The research findings emphasize the importance of public awareness and education as factors influencing active participation in waste management. Policies and regulations that support responsible waste management have been shown to contribute to improved sanitation practices. Therefore, the creation of innovative policies and incentivizing industries and individuals are key to driving successful sanitation initiatives.

Thus, addressing waste management challenges requires a comprehensive and multi-angle approach. Partnerships between government, industry, and the wider community are essential to achieving effective and sustainable sanitation goals. Education programs that reach all levels of society can improve action-taking that is responsive to waste issues. Investment in efficient sanitation technologies and infrastructure should continue to be promoted, while actively exploring and implementing innovative solutions in response to the various environmental challenges faced.

A significant implication for waste management practices from these findings is the need to combine innovative management strategies with community-based approaches, to achieve sustainable outcomes. The integration of new technologies, such as smart waste treatment systems and the use of efficient recycling methods, with the development of public awareness and education on the importance of environmental sanitation, offers opportunities to reduce environmental footprints and promote public health. Successful implementation of this strategy relies heavily on the cooperation of stakeholders, including governments, businesses, and communities, in promoting supportive policies and empowering local initiatives aimed at holistically improving waste management systems.

References

Abdelfattah, A., Ali, S., Ramadan, H., El-Aswar, E., & ... (2023). Microalgae-based wastewater treatment: Mechanisms, challenges, recent advances, and future prospects. *Environmental Science …, Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2666498422000618

Abdussamad, Z. (2022). *Buku Metode Penelitian Kualitatif*. *Query date: 2024-05-25 20:59:55*. https://doi.org/10.31219/osf.io/juwxn

Abubakar, I., Maniruzzaman, K., Dano, U., & ... (2022). Environmental sustainability impacts of solid waste management practices in the global South. *… of Environmental …, Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/1660-4601/19/19/12717

Adlini, M. N., Dinda, A. H., Yulinda, S., Chotimah, O., & Merliyana, S. J. (2022). Metode Penelitian Kualitatif Studi Pustaka. *Edumaspul: Jurnal Pendidikan*, *6*(1), 974–980. https://doi.org/10.33487/edumaspul.v6i1.3394

Afiyanti, Y. (2008). Focus Group Discussion (Diskusi Kelompok Terfokus) sebagai Metode Pengumpulan Data Penelitian Kualitatif. *Jurnal Keperawatan Indonesia*, *12*(1), 58–62. https://doi.org/10.7454/jki.v12i1.201

Agamuthu, P., & Barasarathi, J. (2021). Clinical waste management under COVID-19 scenario in Malaysia. *Waste Management & …, Query date: 2024-06-27 09:04:41*. https://doi.org/10.1177/0734242X20959701

Ahirwar, R., & Tripathi, A. (2021). E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions. *Environmental Nanotechnology, Monitoring & …, Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2215153220303925

Alam, O., & Qiao, X. (2020). An in-depth review on municipal solid waste management, treatment and disposal in Bangladesh. *Sustainable Cities and Society*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2210670719307061

Al-Hazmi, H., Mohammadi, A., Hejna, A., Majtacz, J., & ... (2023). Wastewater treatment for reuse in agriculture: Prospects and challenges. *Environmental …, Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0013935123015153

Alzamora, B., & Barros, R. (2020). Review of municipal waste management charging methods in different countries. *Waste Management*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0956053X2030386X

Anokye, K., Mohammed, A., Agyemang, P., Agya, A., & ... (2024). A systematic review of the impacts of open burning and open dumping of waste in Ghana: A way forward for sustainable waste management. *Cleaner Waste …, Query date: 2024-*

06-27 09:04:41. https://www.sciencedirect.com/science/article/pii/S2772912524000241
Arslan, M., Xu, B., & El-Din, M. (2020). … of SARS-CoV-2 via fecal-oral and aerosols–borne routes: Environmental dynamics and implications for wastewater management in underprivileged societies. *Science of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720342315
Arya, S., & Kumar, S. (2020). E-waste in India at a glance: Current trends, regulations, challenges and management strategies. *Journal of Cleaner Production*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652620327542
Asante-Duah, K. (2021). *Hazardous waste risk assessment*. taylorfrancis.com. https://doi.org/10.1201/9781003070009
Aslam, M., Huang, B., & Cui, L. (2020). Review of construction and demolition waste management in China and USA. *Journal of Environmental Management*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0301479720303790
Awasthi, A., Cheela, V., D'Adamo, I., & ... (2021). Zero waste approach towards a sustainable waste management. *Resources, Environment …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2666916121000013
Ayeleru, O., Dlova, S., Akinribide, O., Ntuli, F., & ... (2020). Challenges of plastic waste generation and management in sub-Saharan Africa: A review. *Waste Management*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0956053X2030180X
Ayilara, M., Olanrewaju, O., Babalola, O., & Odeyemi, O. (2020). Waste management through composting: Challenges and potentials. *Sustainability*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/2071-1050/12/11/4456
Bui, T., Tsai, F., Tseng, M., & Ali, M. (2020). Identifying sustainable solid waste management barriers in practice using the fuzzy Delphi method. *Resources, Conservation and …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0921344919305312
Chen, S., Huang, J., Xiao, T., Gao, J., Bai, J., Luo, W., & ... (2020). Carbon emissions under different domestic waste treatment modes induced by garbage classification: Case study in pilot communities in Shanghai, China. *… of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720307038
Comineti, C., Schlindwein, M., & ... (2024). Socio-environmental externalities of sewage waste management. *… The Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969724042578
D'alessandro, D., Gola, M., Appolloni, L., & ... (2020). COVID-19 and living space challenge. Well-being and public health recommendations for a healthy, safe, and sustainable housing. *Acta Bio Medica …*, *Query date: 2024-06-27 09:04:41*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8023091/

Das, A., Islam, M., Billah, M., & Sarker, A. (2021). COVID-19 pandemic and healthcare solid waste management strategy–A mini-review. *Science of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969721012882

Debrah, J., Vidal, D., & Dinis, M. (2021). Raising awareness on solid waste management through formal education for sustainability: A developing countries evidence review. *Recycling*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/2313-4321/6/1/6

Despoudi, S., Bucatariu, C., Otles, S., & Kartal, C. (2021). Food waste management, valorization, and sustainability in the food industry. *Food Waste Recovery*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/B9780128205631000081

Ding, Y., Zhao, J., Liu, J., Zhou, J., Cheng, L., Zhao, J., & ... (2021). A review of China's municipal solid waste (MSW) and comparison with international regions: Management and technologies in treatment and resource utilization. *Journal of Cleaner …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652621003644

Du, L., Feng, Y., Lu, W., Kong, L., & Yang, Z. (2020). Evolutionary game analysis of stakeholders' decision-making behaviors in construction and demolition waste management. *Environmental Impact Assessment …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0195925519305530

Dubey, S., Singh, P., Yadav, P., & Singh, K. (2020). Household waste management system using IoT and machine learning. *Procedia Computer Science*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S1877050920306876

Esparza, I., Jiménez-Moreno, N., Bimbela, F., & ... (2020). Fruit and vegetable waste management: Conventional and emerging approaches. *Journal of Environmental …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0301479720304448

Evode, N., Qamar, S., Bilal, M., Barceló, D., & ... (2021). Plastic waste and its management strategies for environmental sustainability. *… and Environmental …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2666016421000645

Fadhullah, W., Imran, N., Ismail, S., Jaafar, M., & ... (2022). Household solid waste management practices and perceptions among residents in the East Coast of Malaysia. *BMC Public Health*, *Query date: 2024-06-27 09:04:41*. https://doi.org/10.1186/S12889-021-12274-7

Fan, Y. V., Jiang, P., Hemzal, M., & Klemeš, J. (2021). An update of COVID-19's influence on waste management. *… of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720355431

Fatimah, Y., Govindan, K., Murniningsih, R., & ... (2020). Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia. *Journal of Cleaner …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652620323106

Gollakota, A., Gautam, S., & Shu, C. (2020). Inconsistencies of e-waste management in developing nations–Facts and plausible solutions. *Journal of Environmental Management*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0301479720301699
Gómez-Sanabria, A., Kiesewetter, G., Klimont, Z., & ... (2022). Potential for future reductions of global GHG and air pollutants from circular waste management systems. *Nature …*, *Query date: 2024-06-27 09:04:41*. https://www.nature.com/articles/s41467-021-27624-7
Guo, W., Xi, B., Huang, C., Li, J., Tang, Z., Li, W., Ma, C., & ... (2021). Solid waste management in China: Policy and driving factors in 2004–2019. *Resources …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0921344921003360
Gwenzi, W. (2021). Leaving no stone unturned in light of the COVID-19 faecal-oral hypothesis? A water, sanitation and hygiene (WASH) perspective targeting low-income countries. *Science of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720352803
Hantoko, D., Li, X., Pariatamby, A., Yoshikawa, K., & ... (2021). Challenges and practices on waste management and disposal during COVID-19 pandemic. *Journal of Environmental …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0301479721002024
Hoang, A., Varbanov, P., Nižetić, S., Sirohi, R., & ... (2022). Perspective review on Municipal Solid Waste-to-energy route: Characteristics, management strategy, and role in circular economy. *Journal of Cleaner …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652622015074
Ilyas, S., Srivastava, R., & Kim, H. (2020). Disinfection technology and strategies for COVID-19 hospital and bio-medical waste management. *Science of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720351810
Istrate, I., Iribarren, D., Gálvez-Martos, J., & ... (2020). Review of life-cycle environmental consequences of waste-to-energy solutions on the municipal solid waste management system. *Resources, Conservation …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0921344920300999
Jones, R., Hosking, A., & Moss, E. (2023). *The garbage collection handbook: The art of automatic memory management*. books.google.com. https://books.google.com/books?hl=en&lr=&id=wsbJEAAAQBAJ&oi=fnd&pg=PP1&dq=environmental+sanitation+strategies+challenges+in+waste+management&ots=-fCSDaB_ry&sig=VoBfGam_DutyEVR_wco8UWJ0Nw0
Kabirifar, K., Mojtahedi, M., Wang, C., & Tam, V. (2020). Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review. *Journal of Cleaner Production*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652620313123

Kedzierski, M., Frère, D., Maguer, G. L., & ... (2020). Why is there plastic packaging in the natural environment? Understanding the roots of our individual plastic waste management behaviours. *… of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720335051

Kenny, C., & Priyadarshini, A. (2021). Review of current healthcare waste management methods and their effect on global health. *Healthcare*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/2227-9032/9/3/284

Kesari, K., Soni, R., Jamal, Q., Tripathi, P., Lal, J., & ... (2021). Wastewater treatment and reuse: A review of its applications and health implications. *Water, Air, &Soil …*, *Query date: 2024-06-27 09:04:41*. https://doi.org/10.1007/s11270-021-05154-8

Khan, S., Anjum, R., Raza, S., Bazai, N., & Ihtisham, M. (2022). Technologies for municipal solid waste management: Current status, challenges, and future perspectives. *Chemosphere*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0045653521028757

Khoa, T. A., Phuc, C., Lam, P., & ... (2020). Waste Management System Using IoT-Based Machine Learning in University. *Wireless …*, *Query date: 2024-06-27 09:04:41*. https://doi.org/10.1155/2020/6138637

Kibria, M., Masuk, N., Safayet, R., Nguyen, H., & ... (2023). Plastic waste: Challenges and opportunities to mitigate pollution and effective management. *… of Environmental …*, *Query date: 2024-06-27 09:04:41*. https://doi.org/10.1007/s41742-023-00507-z

Klemeš, J., Fan, Y. V., Tan, R., & Jiang, P. (2020). Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19. *Renewable and Sustainable …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S1364032120301763

Koul, B., Yakoob, M., & Shah, M. (2022). Agricultural waste management strategies for environmental sustainability. *Environmental Research*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0013935121015863

Kubanza, N. S., & Simatele, M. (2020). Sustainable solid waste management in developing countries: A study of institutional strengthening for solid waste management in Johannesburg, South Africa. *Journal of Environmental …*, *Query date: 2024-06-27 09:04:41*. https://doi.org/10.1080/09640568.2019.1576510

Kulkarni, B., & Anantharama, V. (2020). Repercussions of COVID-19 pandemic on municipal solid waste management: Challenges and opportunities. *Science of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969720342157

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*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2666049020300244

Kurniawan, T., Liang, X., O'Callaghan, E., Goh, H., & ... (2022). Transformation of solid waste management in China: Moving towards sustainability through digitalization-based circular economy. *Sustainability*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/2071-1050/14/4/2374

Luttenberger, L. (2020). Waste management challenges in transition to circular economy–case of Croatia. *Journal of Cleaner Production*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652620305424

Magwaza, S., Magwaza, L., Odindo, A., & ... (2020). Hydroponic technology as decentralised system for domestic wastewater treatment and vegetable production in urban agriculture: A review. *… of the Total Environment*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0048969719341312

Malav, L., Yadav, K., Gupta, N., Kumar, S., & ... (2020). A review on municipal solid waste as a renewable source for waste-to-energy project in India: Current practices, challenges, and future opportunities. *Journal of Cleaner …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0959652620332728

Manikandan, S., Subbaiya, R., Saravanan, M., Ponraj, M., & ... (2022). A critical review of advanced nanotechnology and hybrid membrane based water recycling, reuse, and wastewater treatment processes. *Chemosphere*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S0045653521033397

Mazari, S., Ali, E., Abro, R., Khan, F., Ahmed, I., & ... (2021). Nanomaterials: Applications, waste-handling, environmental toxicities, and future challenges–A review. *… of Environmental …*, *Query date: 2024-06-27 09:04:41*. https://www.sciencedirect.com/science/article/pii/S2213343721000063

Mihai, F. (2020). Assessment of COVID-19 waste flows during the emergency state in Romania and related public health and environmental concerns. *… Journal of Environmental Research and Public Health*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/1660-4601/17/15/5439

Murthy, V., & Ramakrishna, S. (2022). A review on global E-waste management: Urban mining towards a sustainable future and circular economy. *Sustainability*, *Query date: 2024-06-27 09:04:41*. https://www.mdpi.com/2071-1050/14/2/647