INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue XI, September 2023

Use of Artificial Intelligence for Waste Management

Gurmehar Kaur, Arvind Dhingra

University of Ottawa, Ottawa, Canada

Guru Nanak Dev Engineering College, Ludhiana, India

DOI: https://doi.org/10.51583/IJLTEMAS.2023.12913

Received: 03 September 2023; Accepted: 20 October 2023; Published: 21 October 2023

Abstract: The problem of waste has assumed a gigantic proportion especially for growing metropolitan cities across the world. With no proper arrangement for waste management, landfills have become mountains which pose serious threats to human health. This paper examines the work that has been done till date for effective waste management and tries to suggest the use artificial intelligence techniques for waste management.

Key Words: Waste Management, Artificial Intelligence, IoT

I. Introduction

Human man kind generates enormous amount of waste. The amount of waste generated in cities is far more than that in villages. In absence of any effective measures for recycling or reuse, the waste is usually dumped in nearby landfills. Every major city we visit in India, there is a mountain of waste at the outskirts much like the one we see when we enter the capital city of Delhi. A lot of research has been done in order to reduce the size of the growing waste mountains but their size keeps of growing sending alarm bells ringing for potential threats on life and health of human beings. This waste does not only pollute the soil but also the water and air around the area where it has been dumped.

Waste can broadly be classified into two types: biodegradable and non biodegradable. Whilst the biodegradable waste is easier to handle as it has a life cycle, the non biodegradable waste assumes a much larger threat. Amongst the non biodegradable waste, plastics form a major chunk of the waste.

Another dangerous waste that is the bane of modern society is the e-waste. E-waste or electronic waste is the waste generated out of disposal of computers, laptops, semiconductor based devices.

Manual waste management which was resorted to till very recently and is still forming an important link in waste management has proved ineffective due to sheer volume of waste being generated and in absence of any effective waste management techniques being employed. Artificial Intelligence holds a ray of hope for an emphatic solution to the ever growing problem. This paper is an attempt to explore as to how artificial intelligence can help in waste management.

II. Present situation

For metro cities like Delhi,Mumbai and industrial cities like Ludhiana, Kanpur, the amount of waste being generated on daily basis far exceeds the amount of waste that can be properly managed. According to the EPA, the amount of municipal solid waste (MSW) in 2018 was 292.4 million tons, which is almost 23.7 million tons more than the amount generated in 2017. This results in large heaps of waste in the landfills and also pollution of water resources in these cities. Artificial Intelligence based methods for waste management hold the key for effective waste management.

In [1],the authors have reviewed the application of artificial intelligence in waste-to-energy, smart bins, waste-sorting robots, waste generation models, waste monitoring and tracking, plastic pyrolysis, distinguishing fossil and modern materials, logistics, disposal, illegal dumping, resource recovery, smart cities, process efficiency, cost savings, and improving public health. By using artificial intelligence in waste logistics , it was proved that a reduction in transportation distance by up to 36.8%, cost savings by up to 13.35%, and time savings by up to 28.22% are achievable.. Artificial intelligence allows for identifying and sorting waste with an accuracy ranging from 72.8 to 99.95%. Artificial intelligence combined with chemical analysis improves waste pyrolysis, carbon emission estimation, and energy conversion. They have also explained how efficiency can be increased and costs can be reduced by artificial intelligence in waste management systems for smart cities.

AI-based techniques are used by researchers[7] for solid waste optimization and prediction (Abbasi and El Hanandeh, 2016; Abdallah et al., 2020). Management of SW is aimed at optimizing various activities involved during the process, such as solid

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue XI, September 2023

waste detection, collection, optimal placement of trash bins, transportation via shortest paths, and disposal. SW prediction deals with estimating the rate/amount of solid waste generated as a function of various predictors.

In [10] the authors have explored the application of AI technologies in various areas of SWM (generation, sorting, collection, vehicle routing, treatment, disposal and waste management planning) to enhance sustainable waste management practices in Australia. To achieve the aims of this study, prior studies from 2005 to 2021 from various databases were collected and analyzed. The study focused on the adoption of AI applications on SWM, compares the performance of AI applications, explores the benefits and challenges, and provides best practice recommendations on how resource efficiency can be optimized to improve economic, environmental and social outcomes. This study found that AI-based models have better prediction abilities when compared to other models used in forecasting solid waste generation and recycling. Findings show that waste generation in Australia has been steadily increasing and requires upgraded and improved recovery infrastructure and the appropriate adoption of AI technologies to enhance sustainable SWM. Australia's adoption of AI recycling technologies would benefit from a national approach that seeks consistency across jurisdictions, while catering for regional differences. This study benefitted researchers, governments, policy-makers, municipalities and other waste management organizations to increase current recycling rates, eliminate the need for manual labor, reduce costs, maximize efficiency, and transform the way we approach the management of solid waste.

In[11], the authors have taken the case of H University in China to analyze the actual situation of waste classification management program on campus including basic situation of all kinds of waste streams from generation to final treatment on campus. Based on the above results, they have attempted to propose an alternative scheme for existing waste classification management program in the university, They tried to propose a framework of waste classification management based on AI technology to improve the performance of waste classification recycling on campus.

III. Use of Artificial Intelligence for waste management

AI based models [4] have been found to be used in many fields of study like engineering, medicine etc.. Advances in artificial intelligence techniques have been found to be appropriate for being instrumental in the waste management field. To ensure environmental safety and public health, waste generation must be adequately controlled. The waste management sector has taken on a new structure as a result of current circular economy (CE) techniques, which create value from trash generated. One of the major problems is the transformation into circular economy, particularly in terms of sorting and classifying generated garbage. However, in the COVID era, the majority of the released trash is mixed with conventional wastes. The epidemic has resulted in massive amounts of infectious garbage. Waste from healthcare facilities must be properly separated at the source, stored, and transported to avoid negative health and environmental consequences along with preserving resource efficiency and material recovery. Although, the waste minimization is commonly implemented at the point of generation, such as the separation of hazardous trash from other wastes. Such objectives can be achieved by incorporating artificial intelligence into the waste management system. Many such models are there which can be implemented in managing the solid waste using artificial intelligence. Each model of artificial intelligence serves a different purpose viz. date for classification and prediction. Additional artificial neural network is used to handle big data for performing geographical analysis. Induction of AI thus helps to optimize waste collection routes of garbage trucks, locate the waste management facilities, estimate waste generation patterns and also used in the simulation of waste conversion processes. Accurate prediction of waste properties leads to a methodical collection, proper treatment and discarding of municipal solid waste.

Waste bin level detection, waste characteristic forecasting, process parameter prediction, process output prediction, vehicle routing, and SWM planning are some of the AI application sectors. The detection of waste in the bin is related with monitoring the fullness of waste bins, whereas waste characteristics prediction includes waste classification, waste compression ratio, and waste generation trends. Waste heating value and co-melting temperature were among the predicted process parameters. Simulation and optimization of biogas generation and leachate creation were included in the process output prediction. The optimization of waste collection routes and frequency was part of the vehicle routing problem. Using cloud based monitoring system, the manual monitoring of dust bins can be avoided. Khan and his co-workers indicated to a form of network that uses data sensing devices to link different points to a network for smart detection, targeting and tracking, monitoring, and management.

IV. Advantages of using AI for waste management

AI is changing the very way we collect, transport, and sort all types of waste from medical waste to bio-hazard waste. Robotics coupled with AI and machine learning have improved the quality of waste management process as it becomes more and more complex, and the health conditions for workers.AI is helped for large-scale sorting facilities or smart sensors on dumpsters, but these technologies are being applied on a smaller scale to stop contamination at the point of disposal.It can save money by

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XII, Issue XI, September 2023

reducing overheads such as the number of trucks that go out. It can boost turnover by reducing contamination resulting in higher-grade recycled products. Additionally, AI recycling can reduce the need for people to carry out potentially dangerous tasks, such as sorting e-waste, which often has toxic chemicals. AI in waste management can help create more efficient, easier-to-use, and cheaper recycling systems, which could boost recycling rates. This will help reduce the amount of waste pollution in our water, air and soil while also reducing the need for virgin resources to be extracted, and the pollution related to these.

V. Conclusion

Use of artificial intelligence for waste management is likely to employed on larger scales in near future. It will definitely act as a booster for effective waste management and help in getting rid of ever growing mountains of waste coming up near cities. Used judiciously it would help in reducing human exposure to harmful waste and also help in saving our environment paving way for coming up of smart cities.

References

1. Fang, B., Yu, J., Chen, Z., Osman Ahmed I., Farghali Mohamed, Ihara Ikko, Hamza Essam H., Ronney David W., Yap Po-Seng, Artificial intelligence for waste management in smart cities: a review. Environ Chem Letters 21, 1959–1989 (2023). https://doi.org/10.1007/s10311-023-01604-3
2. Abbasi M, El Hanandeh A (2016) Forecasting municipal solid waste generation using artificial intelligence modelling approaches. Waste Manag 56:13–22.
3. Abunama T, Othman F, Ansari M, El-Shafie A (2019) Leachate generation rate modeling using artificial intelligence algorithms aided by input optimization method for an msw landfill. Environment Sci Pollution Res 26:3368–3381.
4. Sharma Puneet, Vaid, Upma, Emerging role of artificial intelligence in waste management practices, IOP Conf. Series: Earth and Environmental Science 889 (2021) 012047 IOP Publishing doi:10.1088/1755-1315/889/1/012047
5. Aggarwal S, Jindal A, Chaudhary R, Dua A, Aujla G S and Kumar N 2018 Energy Chain: Enabling energy trading for smart homes using blockchains in smart grid ecosystem Proceedings of the 1st ACM Mobi Hoc Workshop on Networking and Cybersecurity for Smart Cities, Smart Cities Security 2018.
6. Sarowa S, Singh H, Agrawal S and Sohi B S 2018 Design of a novel hybrid intercarrier interference mitigation technique through wavelet implication in an OFDM system Digit. Commun. Networks 4 258–63
7. I. Ihsanullah, Gulzar Alam, Arshad Jamal, Feroz Shaik, [2022] Recent advances in applications of artificial intelligence in solid waste management: A review, Chemosphere, Volume 309, Part 1, 136631, ISSN 0045-6535,
8. Maryam Abbasi, Ali El Hanandeh [2016], Forecasting municipal solid waste generation using artificial intelligence modelling approaches, Waste Management, Volume 56, Pages 13-22, ISSN 0956-053X, https://doi.org/10.1016/j
9. Mohamed Abdallah, Manar Abu Talib, Sainab Feroz, Qassim Nasir, Hadeer Abdalla, Bayan Mahfood, [2020] Artificial intelligence applications in solid waste management: A systematic research review, Waste Management, Volume 109, Pages 231-246, ISSN 0956-053X
10. Lynda Andeobu, Santoso Wibowo, Srimannarayana Grandhi, [2022] Artificial intelligence applications for sustainable solid waste management practices in Australia: A systematic review, Science of The Total Environment, Volume 834, 155389, ISSN 0048-9697
11. Qu Dongxu, [2022] Application of Artificial Intelligence in Waste Classification Management at University, Proceedings of the international conference on intelligent vision and computing