ISSN–2277- 8721

EIIRJ Electronic International Interdisciplinary Research Journal

Volume–XIII, Issues – III May – June 2024

OPEN ACCESS Original Research Article

A COMPARATIVE STUDY OF ECOTECH RIVER WASTE CLEANING ROBOTS WITH MANUAL HUMAN BASED RIVER CLEANING PROCESSES

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Abstract:

Rivers play a vital role in maintaining the balance of ecosystems and providing essential resources for human activities. However, the increasing pollution and waste thrown into rivers pose a significant threat to their health and sustainability. To mitigate this issue, there is a need for the development of eco-friendly technologies that can effectively clean river waste and restore the ecological conditions of water bodies. Eco-friendly technology is the use of engineering models to determine the optimum process for treating polluted river water while minimizing the usage of clean water. This approach addresses the problem of polluted river water, which is often contaminated by untreated urban sewage and used for irrigation and agricultural crop production in various regions such as India. By utilizing self-purification processes such as dilution, sedimentation, and biological processes, the quality of river water can naturally improve but rivers are not getting cleaned thoroughly. Eco-friendly technology involves the use of a machine to lift the waste surface debris from the water bodies, thereby reducing water pollution and minimizing the impact on aquatic animals. The research presents a comparative analysis of eco-friendly mechanisms for floating waste removal from sewage streams, aiming to reduce labour and time while enhancing river health and biodiversity.

Keywords: *Robot River Cleaning, AI River Cleaning, River Cleaning, Waste Removal from River, Manual River Cleaning, Eco-Friendly Technologies*

Introduction:

Rivers are integral components of ecosystems and essential resources for human communities, serving various purposes such as drinking, cooking, and bathing. However, the escalating activities of factories, farms, stores, public utilities, and households result in the consumption of millions of liters of water daily, leading to river pollution. Factors contributing to river pollution include the dumping of garbage and plastic, raw sewage discharge, industrial effluents, and cultural practices like Ganapati Visarjan. The rapid pace of industrialization and urbanization exacerbates this issue, causing a surge in river pollution and posing significant challenges in maintaining healthy river ecosystems.

To address these challenges, various methods have been employed to clean rivers, ranging from basic techniques to manual cleaning approaches and innovative robotic methods. Among these, robotic technology has emerged as a promising solution for river cleaning. Specifically designed to efficiently remove pollutants, these eco-friendly cleaning robots aim to restore the natural balance of river ecosystems. This research paper examines the efficacy of eco-

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friendly cleaning robots in comparison to manual human-based river cleaning processes. By conducting a comparative study, this paper aims to evaluate the effectiveness and efficiency of EcoTech River Waste Cleaning Robots in revitalizing polluted rivers when compared to traditional manual cleaning methods. Through this analysis, insights into the potential of robotic technology to contribute to river waste management and ecosystem restoration will be explored, offering valuable implications for sustainable river management practices.

Literature Survey:

However, the increasing pollution and waste thrown into rivers pose a significant threat to their health and sustainability [1] (Anawar & Chowdhury, 2020). To mitigate this issue, there is a need for the development and implementation of eco-friendly technologies that can effectively clean river waste and restore the ecological conditions of these water bodies. One such eco-friendly technology is the use of engineering models to determine the optimum process for treating polluted river water while minimizing the usage of clean water. This approach addresses the problem of polluted river water, which is often contaminated by untreated urban sewage and used for irrigation and agricultural crop production in various regions such as India. By utilizing self-purification processes such as dilution, sedimentation, and biological processes, the quality of river water can naturally improve. This ecofriendly technology involves the use of a machine to lift the waste surface debris from the water bodies, thereby reducing water pollution and minimizing the impact on aquatic animals. Moreover, the development of autonomous river cleaning robots is eco-friendly technology that can have a significant impact on pollution control [2] (Nair et al., 2019). These robots can operate autonomously in rivers and efficiently clean waste from the water, reducing manual labour and potential risks to human health. So, A robot that cleans the waste autonomously from the water can make a significant impact on waste pollution control. This eco-friendly technology aims to address the challenges of river waste management and improve the overall health and sustainability of rivers. By incorporating advanced technologies such as artificial intelligence, machine learning, and remote sensing, these robots can identify and target specific pollutants in the water, allowing for more efficient and targeted cleaning processes. This ecofriendly technology has the potential to revolutionize the way we clean rivers, making the process more efficient, cost-effective, and environmentally friendly. In research paper [3] (Yang & Kim, 2022), The design process of the river cleaning robot involved studying the bionic top-down approach and incorporating relevant product design elements. By adopting a bionic top-down approach and considering key design elements, such as hydrodynamics and low energy consumption, the river cleaning robot was designed to be large and efficient in removing waste from the water surface. Additionally, the use of renewable energy sources such as solar power and rechargeable batteries ensures that the robot operates in an eco-friendly manner, reducing reliance on non-renewable energy sources and minimizing its carbon footprint. Overall, the development of eco-friendly technology for cleaning river waste involves designing and implementing autonomous robots that can effectively remove surface debris from water bodies [4] (Phirke et al., 2021). Furthermore, using advanced sensor technology, the robot can detect and analyze various types of pollutants in the water, allowing for targeted cleaning strategies (Yang & Kim, 2022). The research paper “A comparative study of EcoTech River Waste Cleaning Robots with Manual Human Based River Cleaning Processes“ shows the processes used in manual river cleaning and robot cleaning methods to clean the river and shows the comparative study between these two techniques.

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Material and Methodology:

Table 1.1 illustrates the various methods utilized for cleaning river waste.

Sr. No.	Types of Cleaning River Methods
1	Self-Purification Process
2	Manual Human based Process
3	Machine Robot based Process

Method 1: Self-Purification Process:

The self-purification process of rivers involves a combination of physical, chemical, and biological mechanisms. Flowing water inherently possesses the ability to cleanse itself through various processes. Physical processes such as dilution, sedimentation, filtering, and aeration aid in the removal of pollutants. Chemical processes including oxidation, reduction, adsorption, and absorption contribute to further purification. Additionally, biological processes such as mineralization and assimilation play a crucial role in enhancing water quality.

However, contemporary watercourses are experiencing severe pollution due to excessive discharge of waste and substances, overwhelming the natural capacity of water bodies to self-cleanse.

This method underscores the importance of understanding and leveraging the inherent self-purification capabilities of rivers while acknowledging the challenges posed by modern pollution levels.

Method 2: Manual Human Based River Cleaning:

Manual human-based river cleaning involves the utilization of boats equipped with specialized tools such as nets, skimmers, and other equipment to manually remove debris from the surface of rivers. Individuals and organizations undertake this process, collecting debris in bags for disposal.

Humans possess the ability to adapt to changing conditions and identify complex or unusual items that may require special attention during the cleaning process. They can make instant decisions and navigate difficult areas, ensuring thorough removal of debris from the river surface.

Unlike automated methods, manual human-based river cleaning does not follow a fixed path for cleaning planning. Instead, the cleaning process can be extended based on the availability of plastic and waste materials in rivers.

However, manual cleaning poses risks to the safety of individuals, especially in challenging environments or when dealing with hazardous materials. It is also a time-consuming and labour-intensive process, requiring two or more people to clean the rivers effectively.

Moreover, deeply downward cleaning of rivers manually is a challenging and complex task, limiting the focus of manual cleaning methods to surface debris removal or near-surface pollutants. Additionally, manual cleaning operations cannot be conducted 24/7, further limiting their effectiveness in maintaining river cleanliness.

Figure1: Shows the Manual Human Based River Cleaning by boats and nets

Figure 1

ISSN–2277- 8721

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As some rivers are full of dumped garbage shown in Figure 2 so Manual based river cleaning methods to be applied to clean rivers by boats and nets but after that too sometimes manually to collect some remain waste by hands and re-cleaning is required to clean the river thoroughly and to maintain ecosystem. Figure 3 shows the collection of plastic waste manually.

Figure 2

Figure 3

Method 3: Eco Friendly Machine-Robot based River Cleaning Process:

The eco-friendly machine-robot-based river cleaning process utilizes specialized machines to lift surface debris from water bodies, facilitating the removal of pollutants and waste. By incorporating cutting-edge technologies such as Artificial Intelligence (AI), Machine Learning (ML), and Remote Sensing, robots can identify and target specific pollutants in the water, enabling more efficient and targeted cleaning processes. These robots are designed to operate autonomously within rivers, reducing the need for human intervention and minimizing manual labour requirements. The use of renewable energy sources such as solar power and rechargeable batteries ensures that robots operate in a low energy consumption, eco-friendly manner, thereby minimizing their carbon footprint. This process aims to reduce water pollution and minimize the impact on aquatic animals, contributing to the overall health and sustainability of river ecosystems.

By automating cleaning processes, the need for manual labour is significantly reduced, thereby minimizing associated risks and enhancing overall efficiency. Robots have the capability to work continuously, 24/7, without experiencing fatigue, and cover large areas more efficiently than manual labour.

However, there are several challenges associated with this method, including adaptability issues where robots may struggle to adapt to changing environmental conditions or effectively identify and handle complex and irregularly shaped debris. The high initial investment in robotics technology for river cleaning can be substantial, impacting the overall cost-effectiveness of the process. Additionally, there may be limitations in achieving deep cleaning of rivers, particularly in navigating fixed paths and accessing deeper water depths.

Despite these challenges, the eco-friendly machine-robot-based river cleaning process holds significant promise for enhancing the efficiency, effectiveness, and sustainability of river cleaning efforts.

Figure 4 shows the whale shark-inspired autonomous robot drone that eats marine litter and Figure 5 shows the robot eco-friendly technology to clean river surface waste.

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Figure 4

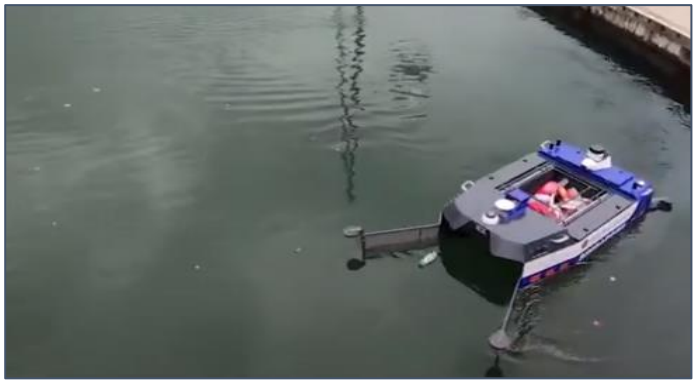

Figure 5

Survey Analysis:

A questionnaire was prepared and data were collected from a diverse range of respondents, including school students, college students, housewives, teachers, and others. Approximately 100 responses were obtained, revealing notable insights.

According to the survey findings, a significant number of respondents reported observing the use of robots in various applications, ranging from driving cars to cleaning homes and manufacturing products. This observation is illustrated in Figure 6.

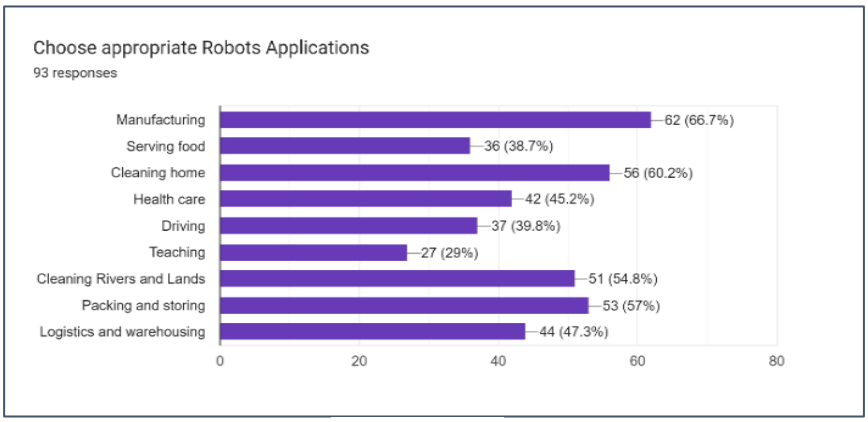

Figure 6

Figure 7 illustrates that the safety of human life is not guaranteed during the deep cleaning of rivers, especially when compared to the use of robots. Figure 8 demonstrates that 50% of respondents indicated that 80 to 100 percent river cleaning is achievable more effectively by robots than by humans.

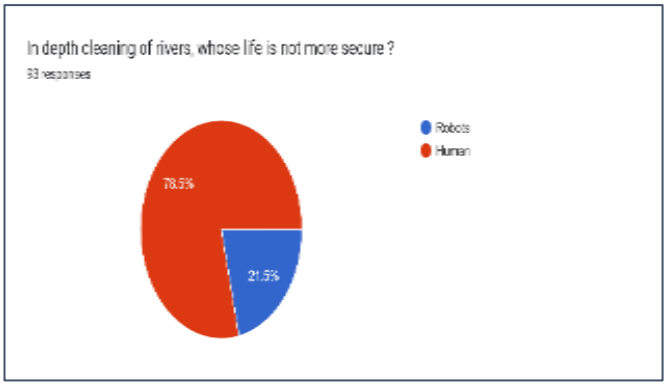

Figure 7

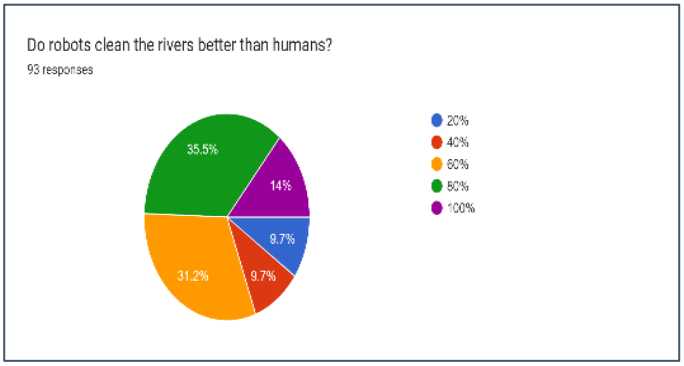

Figure 8

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Figure 9 depicts that while robots may initially incur higher costs compared to humans in river cleaning activities, they are considered cost-effective in the long term due to their efficiency and effectiveness. This initial investment in technical machine robot setup leads to overall cost savings over time.

In Figure 10, it is evident that humans are perceived as more intelligent than robots, as robots are created and designed by humans themselves. Furthermore, the concept of machine learning, integral to robots' functionality, is also developed by humans.

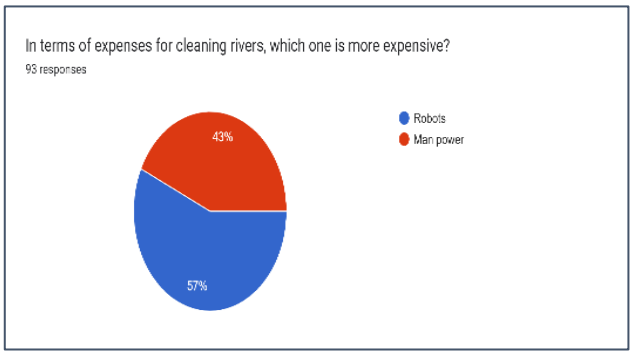

Figure 9

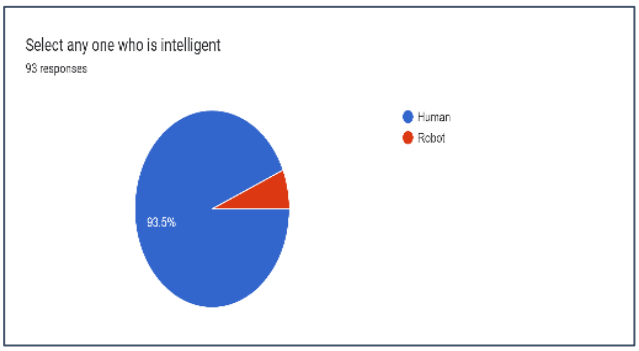

Figure 10

Results and Discussion:

Table 1.2 shows the comparative analysis of efficiency between Eco Friendly Machine-Robot river waste cleaning as Manual Human based River Cleaning Process.

Table 1.2

Sr. No.	Manual Human based River Cleaning Process	Eco Friendly Machine-Robot based River Cleaning Process
1	Manual method is slower as compared to Robotic River cleaning.	Robotic river cleaning is faster compared to manual methods.
2	Humans can cover large area of river for cleaning based on the availability of plastic and waste in rivers.	Robots can cover large areas more efficiently than manual labour.
3.	Humans can't work 24 by 7 continuously.	Eco Friendly Machine-Robot can work 24 by 7 continuously.
4.	More man power is required if large amount of garbage/waste is present.	Only one Eco-friendly Robotic machine is sufficient irrespective of amount of waste material present in river.
5	Manual method of cleaning will not work in disturbance of weather condition.	Robots can work in any weather condition, whereas manual labour may be hindered by adverse weather.
6	Life risk is always there.	There is no life risk.
7	The labour charges will remain always.	Initial expenses for acquiring and maintaining robotic machines, they can be more cost-effective in the long run compared to continuous labour charges for manual cleaning.
8	Manual-based river cleaning often involves the use of boats powered by fossil fuels, which indeed contribute to carbon emissions and pollution. These emissions can further degrade the quality of the water and harm the surrounding environment, counteracting the efforts of cleaning.	Robots operate in a low energy consumption, eco-friendly manner, thereby minimizing their carbon footprint.

ISSN–2277- 8721

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Conclusion:

The commendable efforts of humans in river cleaning are acknowledged, yet they encounter challenges such as limited resources and the necessity for stringent safety precautions. Additionally, the effectiveness of manual cleaning methods is subject to scrutiny.

The introduction of eco-friendly cleaning robots has the potential to revolutionize river revitalization efforts. While human contributions remain invaluable, the integration of robotic technology can significantly enhance the sustainability of river ecosystems. This includes minimizing manual stress, reducing human intervention, promoting environmental friendliness, ensuring reliable stability, and achieving cost efficiency and economic viability.

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Cite This Article:

Lala R. & Pal K. (2024). *A Comparative Study of Ecotech River Waste Cleaning Robots with Manual Human Based River Cleaning Processes.* In Electronic International Interdisciplinary Research Journal: Vol. XIII (Number III, pp. 22–28). **DOI.** ***https://doi.org/10.5281/zenodo.11310958***