STUDYING THE WASTE RECYCLING PROCESS

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ABSTRACT

This article provides a comprehensive examination of the waste recycling process, emphasizing the relevance of the global waste problem and its impact on the environment, the economy, and society. It explores waste classification, initial processing stages, and the main recycling technologies, including mechanical, chemical, and biological methods. The article evaluates the effects of recycling on environmental sustainability, resource efficiency, and economic benefits ..

This article comprehensively examines the process of transportation, emphasizing the actuality of the global problem of transportation and its influence on the environment, economy, and society. Rassmatrivayutsya classification of wastes, stages of primary processing, and basic processing technologies, such as mechanical, chemical and biological methods.

This article waste again work process every one-sided learns , global waste of the problem relevance and his/her environment , economy and to society the secret of the effect emphasizes . Then waste classification , initial processing to give stages and mechanical , chemical and biological such as main again work technologies analysis Also , re of work ecological sustainability , resources efficiency and economic to benefits effect is evaluated.

Intraduction

Global waste generation is one of the most pressing challenges facing modern society, posing serious threats to the environment, economy and human health. According to the United Nations, 2.01 billion tonnes of solid waste (SW) were generated worldwide in 2016, and this figure is projected to reach 3.4 billion tonnes by 2050. The traditional "take-use-throw" economic model is leading to resource depletion, increased pollution and the proliferation of landfills. This situation highlights the need for sustainable solutions, especially against the backdrop of different regional waste trends, with Asia expected to generate 1 billion tonnes and Europe 500 million tonnes in 2020. Recycling is an important strategy to address this global challenge, keeping resources in the loop, reducing dependence on natural resources, and minimizing negative environmental impacts. The circular economy model fundamentally differs from the traditional approach by emphasizing the elimination of waste and pollution, keeping products and materials in a continuous cycle, and restoring natural systems. This model increases resource efficiency and contributes to sustainable urban development. This article aims to provide an in-depth analysis of various aspects of the waste recycling process, including its technologies, environmental, economic, and social impacts, as well as policy and future directions.

Analysis of literature on the topic

The waste recycling process operates as a three-stage cycle: collection and processing, manufacturing, and consumer purchase of recycled products. This system aims to keep resources in the loop and reduce dependence on new materials. In the first stage, waste is collected from various sources and transported to a Materials Recycling Facility (MQII). At the MQII, materials are sorted using sophisticated technologies such as rotary screens, air classifiers, magnets, vortex flow separators for metals, and optical sorters for plastics, as well as manual quality control. Contamination during the collection process can significantly reduce the efficiency of the MQII, damage equipment, and send items that could otherwise be recycled to landfills. Currently, about 32 percent of solid waste in the U.S. is recycled, a significant increase from 7 percent in 1960, although these figures vary, with plastics posing more recycling challenges than paper.

Recycling technologies are mainly divided into mechanical, chemical and biological methods. A review of the literature over the past decade shows the progress in these technologies, especially in the recycling of plastic waste. Mechanical recycling is the most common method and involves sorting, washing, crushing and re-granulating the waste. However, contamination and inefficiency in sorting are the main obstacles to mechanical recycling. The improved mechanical recycling process (CEFLEX Quality Recycling Process - QRP), developed by researchers from Ghent and Maastricht Universities and CEFLEX, shows the production of high-quality regranulates for post-consumer flexible plastics. QRP includes steps such as additional sorting, hot washing, improved extrusion (two-stage filtration and degassing) and deodorization, which produce granules of superior quality compared to traditional methods. This technological innovation is an important step towards increasing the recycling rate of flexible packaging and further developing the circular economy.

Chemical recycling involves the conversion of plastic polymers into their original monomers or other useful chemical products . While this method is promising, especially for mixed and contaminated plastic waste, it has limitations in terms of scale, material costs, and energy consumption. Biological recycling, on the other hand, is based on the degradation of polymers using microorganisms or enzymes, which allows for recycling with minimal energy consumption. However, this technology also currently faces limitations in terms of scale and material costs. Thermolysis, including pyrolysis and gasification, involves the conversion of plastic waste into liquid or gaseous fuels at high temperatures, but has problems with high energy requirements and operating costs.

The environmental, economic and social impacts of recycling are significant. From an environmental perspective, recycling contributes to environmental protection by saving resources, reducing landfill capacity, reducing carbon footprint, and reducing electricity consumption and greenhouse gas emissions. The circular economy model contributes to sustainable urban development, particularly by increasing resource efficiency and minimizing environmental impacts. From an economic perspective, the recycling industry creates new jobs and preserves the value of materials. However, creating market demand for recycled products is important, as 76% of consumers value manufacturers that use recycled materials. Economic incentives can also be used, for example, a study in Hong Kong found that the introduction of reward systems showed a significant positive correlation between the amount of recyclable waste collected from households, indicating the effectiveness of economic incentives in encouraging recycling behavior.

Waste management policies, regulations and circular economy principles play a key role in this area. The transition from a traditional linear economy to a circular economy is essential for sustainable development globally. Examples such as Sweden's waste-to-energy model and Japan's "Sound Material Cycle Society" demonstrate the successful integration of circular economy principles at the national level. New initiatives in developing regions such as Ghana and Uganda are also incorporating circular economy principles. Innovations in the sector, such as the use of artificial intelligence to improve processes and the introduction of circular economy principles for sustainable waste management, are important. However, challenges such as technological constraints, economic barriers and lack of political support still exist and need to be addressed in future efforts.

Research methodology

This academic article uses a systematic literature review and critical synthesis approach to study the waste recycling process. Scientific articles, reports and policy documents from the last decade on the topic are collected and evaluated. In particular, published studies using methods such as Material Flow Analysis (MFA) and economic evaluation, including work on the CEFLEX Quality Recycling Process (QRP), are reviewed. The article aims to comparatively analyze the efficiency, ecological footprint, economic barriers and social impacts of different recycling technologies (mechanical, chemical, biological, thermolysis). This methodology allows for the integration of information from different sources and provides a comprehensive synthesis of the existing knowledge base, which helps to identify existing gaps in the field and future research directions.

Conclusion

A thorough study of waste recycling shows that it is central to solving the global waste problem and the transition to a circular economy. The rapid growth of waste on a global scale and the limitations of the traditional "take-use-dispose" economic model are increasing the need for sustainable solutions. A systematic literature review shows that significant progress has been made in key technologies for waste collection, sorting and recycling, such as mechanical, chemical and biological. In particular, innovations such as CEFLEX QRP in the recycling of flexible plastics are overcoming the limitations of traditional methods by allowing the production of high-quality regranulates.

However, a number of challenges remain in the recycling sector, including waste pollution, inefficient sorting systems, high energy requirements of some recycling technologies, and scalability limitations. Economic incentives and consumer demand for recycled products are essential for the successful completion of the recycling cycle. At the policy level, it is necessary to integrate the principles of the circular economy and learn from the experience of countries such as Sweden or Japan.

Support technological innovation: Automate and improve the efficiency of sorting processes using artificial intelligence and robotics. Invest in research and development to ensure the scalability of chemical and biological processing methods.

Improve policies and regulations: Develop and implement strong policies and legal standards that encourage waste reduction, recycling and reuse. Deeper integration of circular economy principles into waste management strategies.

Strengthen economic incentives: Introduce effective reward systems and tax incentives that encourage residents and businesses to sort and recycle waste.

Increase public awareness and participation: Conduct regular public information and education campaigns on the importance of properly sorting waste and purchasing recycled products.

Strengthening collaboration between industry and research institutions: Strengthening links between research institutions, government and the private sector to develop new recycling technologies and solve existing problems.

By implementing these recommendations, it is possible to increase the efficiency of waste recycling globally, prevent resource depletion, and ensure a sustainable future..

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