

Green Economics: Unveiling the Economic and Environmental Dynamics of Recycling Initiatives

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ABSTRACT

Recycling stands out as a widely embraced waste management strategy globally, exerting a transformative influence on resource preservation, pollution mitigation, and the curbing of landfill waste. This research seeks to enhance our comprehension of sustainable recycling methodologies by delving into economic dynamics, environmental considerations, technological progress, policy structures, and social factors within the realm of recycling endeavors. The objective is to furnish crucial insights for governmental bodies, corporations, and communities embarking on their sustainability journeys. Rigorous quantitative analysis was employed to amalgamate the amassed data, scrutinizing trends, patterns, and the interplay between recycling and its repercussions across various domains, including economics, technology, and the environment. The findings pertaining to economic dynamics reveal a robust correlation between recycling initiatives and factors such as employment rates, compensation levels, and tax revenues. The study underscores the significance of well-defined policy and regulatory frameworks in the realm of recycling, with a specific focus on the situation in the Philippines.

1. Introduction

Our world's evolving consumerism produces a mass amount of waste. According to United Nations Environment Programme (UN - Environment Programme, 2023), society creates an estimated 2.24 billion tons of waste each year, with just 55% managed in controlled facilities, creating a complex story into the fabric of our social and environmental surroundings. This waste does not simply disappear. In fact, it has an impact on the environment, the economy, and the complex systems that assist life on our planet. Thus, by recognizing this challenge, entrepreneurs have created innovative solutions, such as recycling systems, to minimize environmental damage and waste output.

In recent decades, the world has experienced rapid economic growth, but often at the expense of the environment. Pollution, waste accumulation, and global warming are some examples of the negative impacts produced by human activities. One solution that is increasingly being recognized to face this challenge is the concept of a "green economy", namely an economic approach that prioritizes a balance between economic growth and environmental sustainability. In the midst of growing awareness of the importance of environmental sustainability, recycling initiatives have emerged as one of the main strategies in realizing a green economy which aims to reduce environmental impacts while still supporting economic growth (Haas et al., 2015).

Recycling is the process of gathering, processing, and changing waste or scrap materials into new goods that provides an appealing option. It gives new purposes to garbage, preserving its economic worth and keeping it away of landfills. In 2023, the World Business Council for Sustainable Development emphasized recyclability as a major pillar of sustainable business practices (Damanhuri, 2023).

Recycling not only helps our environment improve, but it also provides economic opportunities. A study like (Pepino, 2019) recognizes the financial incentives associated with recyclable materials in the Philippines. It encourages individuals and businesses to participate in waste collection and recycling. In fact, materials such as plastics are among the most valuable recyclable garbage. With this, it not only lowers the risk of pollution, but it also promotes good waste management, specifically in communities with limited access to regular waste disposal services. However, current recycling facilities only process a tiny percentage of recyclable plastic materials, with the majority of wasted plastic trash going in landfills or the ocean.

However, despite its great potential, implementing recycling initiatives faces a number of challenges. In many developing countries, recycling infrastructure is still inadequate, while public awareness of the importance of recycling is often low. Additionally, some industries are reluctant to switch to using recycled materials due to cost, quality concerns, or lack of economic incentives. In this context, it is important to understand how recycling initiatives can

support the transition to a green economy, as well as how economic and environmental dynamics interact in this process.

The green economy prioritizes the principle of sustainability, where economic activities must take into account long-term environmental impacts. Recycling is an important pillar in this effort, with the aim of reducing waste, reusing materials that can be processed, and reducing dependence on new raw materials. In several developed countries, recycling initiatives have succeeded in showing how this sector not only reduces negative impacts on the environment, but also produces positive impacts on the economy. The recycling industry opens up new business opportunities, creates jobs, and contributes to innovation in the efficient use of resources.

Thus, the question arises: how can recycling affects the world of economics, the cleanliness of our environment, the advancements of technologies, the making of laws and policies, and the dynamics in our society? This study looks into the intricate relationship of economic dynamics, environmental issues, technological advancements, policy frameworks, and social dynamics in the context of recycling activities. It seeks to provide a thorough understanding of the effects and possible synergies of sustainable recycling practices, with a focus on the interconnectivity of the stated dynamic factors. This also highlights the need for more efficient and comprehensive recycling systems. Through thorough analysis, we will investigate the economic contributions, market impacts and environmental repercussions of recycling activities, providing vital

insights for governments, corporations, and communities embarking on their own sustainability journeys. This study aims to expand the understanding of sustainable recycling methods by investigating economic and environmental factors, ultimately informing future research and policy decisions for a more sustainable future.

2. Methodology

The method used in this research is a thorough quantitative analysis was conducted to synthesize the collected data, investigating trends, patterns, and relationships between recycling and its effects on various sectors (economics, technology, environment, etc.). This analysis employed statistical and correlation methods such as Spearman's rank correlation coefficient to examine these relationships. For example, the researcher investigated the correlation between recycling rates and economic growth in different countries to explore the potential economic benefits of recycling initiatives. Additionally, we examined patterns in technological advancements for waste management and their connection to specific recycling policies, providing insights into the policy landscape shaping these innovations. By analyzing these relationships, the researcher gained a deeper understanding of how recycling affects various domains as outlined in our research question. The quantitative findings will be further presented using bar graphs and tables, facilitating clear and concise communication of the results.

Quantitative research provides a solid foundation for in-depth understanding of phenomena that can be measured numerically. In this book, we will explore quantitative methods that can be applied to understand and analyze data with a scientific approach. Quantitative research provides the power to translate real-world complexity into crunchable numbers, opening vast doors for knowledge development and problem solving. Using this approach, researchers can explore relationships between variables, identify patterns, and make strong generalizations to support their findings (Sugiyono, 2017).

3. Results And Discussion

Upon collecting the data, the findings are thoughtfully categorized into five key factors influenced by recycling initiatives.

Economic Dynamics of Recycling

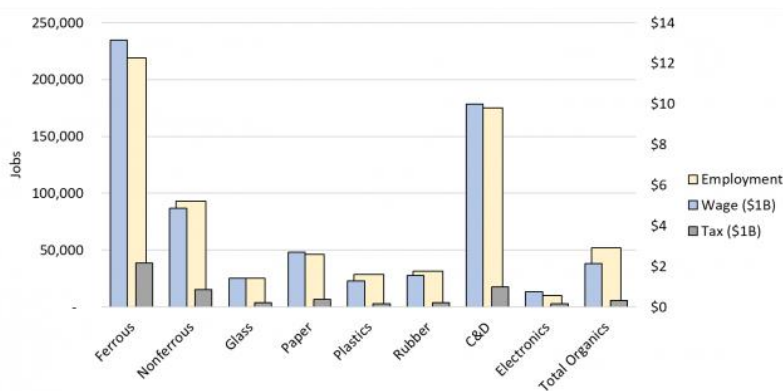


Figure 1. Recycling Economic Information (REI)

Source: EPA, 2023

A review of the 2023 US EPA Recycling Economic Information (REI) Report demonstrates a strong link between recycling and good economic indicators. In 2012, the US recycling business created 681,000 employment, with total compensation of \$37.8 billion and tax income of \$5.5 billion. Notably, each 1,000 tons of processed recyclables generates around 1.17 employment, with average salaries of \$65,230 and tax income of \$9,420. This far outperforms landfill-based waste management in terms of job creation and economic contribution (EPA, 2023).

Further data demonstrates that the ferrous metals industry outperforms other sectors in terms of job creation, wages, and tax income. Several reasons contribute to this, including:

- **Established infrastructure:** The ferrous metals industry already has well-developed collecting and processing infrastructure, resulting in effective recycling operations.
- **High demand for recycled materials:** Recycled ferrous metals, such as steel, require less energy and resources than virgin alternatives, making them a more cost-effective and sustainable option for a variety of industries, hence increasing demand and economic activity.
- **Technological advancements:** Investing in novel technology for sorting, processing, and refining recycled ferrous metals improves their quality and competitiveness, hence increasing the sector's economic effect.

These findings are consistent with Eco-Cycle's (2022) research, which shows that Zero Waste programs that prioritize reuse, repair, and composting in addition to recycling generate more jobs per ton of material processed than landfills and incinerators. This demonstrates the tremendous economic potential of implementing more sustainable waste management strategies. Real-world examples, such as South Carolina's 44% job growth and a remarkable 375% increase in economic impact (not merely quadrupling) between 2006 and 2014 as a result of recycling industry investments, support this thesis. Similar accomplishments may be found in Minnesota and other Northeastern states, proving the extensive economic benefits of strong recycling systems (Demonteverde et al., 2022).

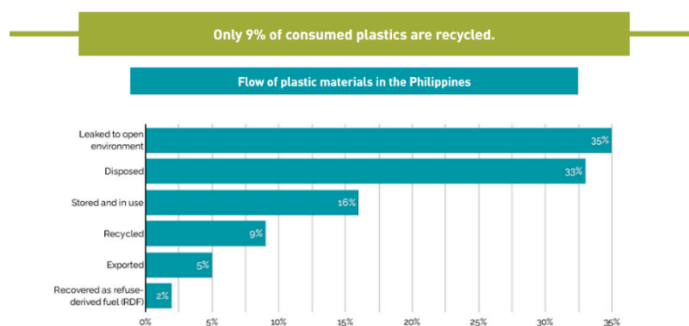


Figure 2. Flow Plastic Material in the Phillipines

Source: Center for International Trade Expositions and Missions

Despite global optimism, the Philippines faces distinct hurdles in plastic recycling due to limited infrastructure and insufficiently enforced rules. According to the Center for International Trade Expositions and Missions, just 9% of post-consumption plastic

packaging is recycled, with the vast majority ending up in landfills, harming the environment, or entering the ocean (Center for International Trade Expositions and Missions, 2023).

However, this complex scenario provides opportunity for creative approaches. Small and medium-sized firms (SMEs) such as Plastic Bank, GreenAntz, and Pure Oceans demonstrate the possibility for economic growth by implementing sustainable practices. Plastic Bank's relationship with Coca-Cola diverted 200,000 kg of plastic from landfills in 2022, while also enhancing community livelihoods through waste collection, with waste collectors earning an estimated \$120,000 (Angelia, 2023). GreenAntz converts plastic trash into environmentally beneficial construction materials, replacing resource-intensive virgin materials and developing new markets for recycled plastics (GreenAntZ, n.d.). Pure Oceans aims to transfer coastal plastic into the circular economy, reducing ocean pollution and creating jobs in the process (PureOceans, n.d.). These examples highlight the potential for a thriving circular economy in the Philippines, which addresses both environmental and economic problems.

In conclusion, the economic analysis highlights the significant positive impact of recycling activities around the world, including job creation, higher incomes, and more tax revenue. The ferrous metals business shows how established infrastructure, significant demand, and technological improvements may be used to maximize the benefits of recycling. Despite the hurdles in the Philippines,

enterprising SMEs illustrate the possibility of a sustainable circular economy that helps both the environment and the local economy. Moving forward, continued efforts to enhance infrastructure, enforce rules, and invest in recycling programs are essential for reaping the full economic and environmental benefits of this critical practice (Agaton et al., 2020).

Environmental Dynamics of Recycling



Figure 3. Environmental Dynamic of Recycling

Source: National Institute of Health (NIH)

As recycling means the collection, processing, and transformation of items that were previously deemed waste into new goods, it also has a great impact in our environment. Recycling conserves resources and protect the environment. It reduces the amount of waste sent to landfills, conserving natural resources such as timber, water, and minerals and can also prevent pollution. According to a study conducted by National Institutes of Health

entitled “ (National Institute of Health (NIH), n.d.)” Embracing recycling practices stands as a compassionate choice, diminishing our reliance on finite natural resources:

- A staggering 94% of the natural resources consumed by Americans are non-renewable, witnessing an ascent from 59% in 1900 to 88% in 1945.
- By actively participating in recycling, we safeguard non-renewable resources. For instance, neglecting to recycle paper would necessitate harvesting 80% more wood by 2010 to meet the escalating demand for paper. Conversely, conscientious paper recycling reduces this requirement to a mere 20%.
- The act of recycling aluminum showcases its environmental grace, demanding a remarkable 95% less energy compared to manufacturing it from raw materials.
- Opting for products crafted from recyclables doesn't merely reduce waste; it embodies an earnest commitment to energy conservation. Recycled steel leads the way with a 60% reduction in production energy, followed by recycled newspaper at 40%, recycled plastics at 70%, and recycled glass at 40%.
- Shifting from virgin ore to scrap steel in the production of new steel not only conserves resources but also manifests as an eco-conscious choice, requiring 40% less water and generating a staggering 97% less mining waste. This compassionate approach to resource utilization fosters a sustainable and considerate relationship with the environment.

Recycling is an important ally in the fight against climate change since it saves energy and reduces raw material extraction. Recycling helps to make the world a more sustainable and environmentally sensitive place by reducing waste and pollution. It creates a "green" mindset that goes beyond individual activities, encouraging a collaborative effort to preserve natural resources. Adopting recycling techniques not only tackles immediate environmental concerns, but also provides the groundwork for a more environmentally conscious future. Recycling, with its numerous advantages, emerges as an essential tool in the ongoing global goal of environmental protection and the building of a harmonious ecological equilibrium (UNFCCC, 2020).

In summary, Recycling has a revolutionary impact on resource conservation, pollution reduction, and landfill trash minimization. Supported by a National Institutes of Health study, it emphasizes the importance of reducing reliance on nonrenewable resources, demonstrating an alarming 94% consumption rate among Americans. Active recycling protects these resources, as evidenced by considerable reductions in wood harvesting for paper and substantial energy savings, particularly in aluminum recycling. Beyond waste reduction, recycling demonstrates a strong commitment to energy conservation, establishing it as an important ally in the worldwide fight against climate change. It is critical in the ongoing effort to save the ecosystem and build a healthy ecological balance.

Technological Innovations

Due to the sheer volume of waste accumulating, numerous individuals find themselves grappling with the challenge of effectively handling their own waste. Hence, people are being innovative and exploring various methods to contribute to waste reduction through the adoption of recycling technologies. Through research, we have studied the technologies that has been made for the sake of recycling initiatives. Some of the technological innovations are given below:

- Smart Bins - can identify the type of waste being deposited and autonomously sort it based on the detected characteristics.
- 3D Printing - Utilized for the recycling of plastic waste into fresh products, this technology facilitates the production of new items from recycled plastic, thereby diminishing the demand for virgin materials and minimizing waste.
- Biodegradable Plastics - Plastic that break down through natural processes, diminishing the accumulation of plastic waste in landfills.
- Pyrolysis - A process that involves converting plastic waste into fuel, providing a means to repurpose challenging-to-recycle plastics and thereby lessening the overall plastic burden on landfills

Recycling technological developments are essential for addressing the waste management dilemma. Key technologies that contribute to waste reduction and recycling include smart bins, 3D printing for plastic recycling, biodegradable plastics, and pyrolysis.

These innovations demonstrate humans' resilience and inventiveness in generating solutions for efficient trash management. The use of technology not only improves the efficiency of recycling processes, but it also creates new opportunities for repurposing materials and lowering the demand for virgin resources. The technological study underlines the need for continued research and development in recycling technology in order to promote sustainable waste management methods.

Policy and Regulatory Framework

As the evolution of recycling endeavors strives for the collective betterment of our society, the Philippines is actively committed to mitigating the likelihood of recurring patterns. To fortify this commitment, the country has established and continues to update policies and regulations addressing recycling and related subjects.

- The Republic Act (RA) No. 9003 or the “Ecological Solid Waste Management Act of 2000” - Provides the necessary policy framework, institutional mechanisms, and directives to local government units (LGUs), empowering them to achieve a 25% reduction in waste by developing integrated solid waste management plans that emphasize the 3Rs principles (reduce, reuse, and recycle). This provision can help to improve and facilitate recycling activities by developing a comprehensive and coordinated approach to waste management, boosting resource efficiency, and reducing environmental impact.

- The Republic Act (RA) 8749 or the “Philippine Clean Air Act of 1999” - Strives to develop a comprehensive national air pollution management program that encourages citizen and industry engagement and self-regulation through the use of market-based instruments. This goal aims to develop a comprehensive plan for air pollution control, encouraging active engagement and regulatory compliance among citizens and enterprises through market-driven methods.
- Presidential Decree No. 1067, or the Water Code of the Philippines - Creates a decree establishing a water code, amending and combining the laws governing the ownership, appropriation, utilization, exploitation, development, conservation, and preservation of water resources.
- Presidential Decree No. 1586 (Establishing the Environmental Impact Statement System) - Implements an environmental impact statement system, which includes additional environmental management procedures and serves a variety of functions.
- Department Administrative Order No. 2013-22 (Hazardous Waste Management) - The state's policy is to restrict, limit, or prohibit the importation, manufacture, processing, sale, distribution, use, and disposal of chemical substances and mixtures that pose excessive dangers to human health or the environment. It also seeks to ban the entry, even in transit, of hazardous and radioactive wastes into Philippine territory for

whatever reason. Furthermore, the policy aims to advance and facilitate research and study on harmful chemicals, hazardous materials, and nuclear waste.

- Local Government Codes - Local governments regularly participate in garbage management and recycling projects. Local legislation and regulations vary, and many cities and municipalities have their own garbage management strategies.

Finally, the Philippines illustrates a strong link between recycling and a sound policy framework. Legislative acts such as the "Ecological Solid Waste Management Act" give critical guidelines and methods for local government units (LGUs) to achieve trash reduction goals by improving and coordinating recycling programs. Policies like the "Philippine Clean Air Act" and "Hazardous Waste Management" highlight the importance of sustainable practices and legislative support. The engagement of local government units in waste management initiatives, as mandated by the Local Government Codes, demonstrates a decentralized approach customized to the different municipal demands. Overall, these policies demonstrate the country's commitment to incorporating recycling within a comprehensive and growing environmental strategy (G.O.V.P.H., 2023).

Social Dynamics

Numerous factors contribute to the intricate social dynamics involved in recycling initiatives. Table 1 presents a selection of these

influential factors that play a role in shaping and influencing recycling endeavors.

Table 1. shaping and influencing recycling endeavors.

	Mean	Standard Deviation	Descriptive Equivalent
Attitude	4.15	0.248	High
Knowledge	4.39	0.152	Very High
Practice	4.06	0.252	High

Descriptive Equivalent	
Mean Range	Interpretation
4.20-5.00	Very High
3.40-4.19	High
2.60-3.39	Moderate
1.80-2.59	Low
1.00-1.79	Very Low

Source: Demonteverde

According Demonteverde et al.'s study demonstrates that students had a good attitude toward waste management, with excellent ratings for Attitude, Practice, and Knowledge. Despite this, statistical analysis shows that Practice has the lowest score, indicating a need for more active engagement in establishing waste management strategies. The findings highlight a potential mismatch between theoretical comprehension and practical use. To bridge this gap, focused interventions, such as hands-on activities or awareness campaigns, must be used to transfer positive attitudes and knowledge into daily waste management behaviors. Achieving successful waste management requires not only knowledge and positive attitudes, but also their actual application in everyday life (Demonteverde et al., 2022).

Finally, Demonteverde et al.'s study demonstrates a beneficial relationship between students' attitudes, practices, and knowledge of waste management. While the study found positive attitudes and theoretical understanding, the lower practical score shows a gap in turning knowledge into active waste management behaviors. This underscores the need of focused interventions, such as hands-on activities and awareness campaigns, in bridging the gap between theory and practice. Successfully integrating waste management into daily life requires not only positive attitudes and knowledge, but also their efficient application. Addressing the link between recycling and social dynamics necessitates comprehensive methods that enable individuals to turn awareness into real and sustainable waste management actions (Demonteverde et al., 2022).

4. Conclusion

The conclusions of this research show that recycling has complex and interrelated impacts on various economic, environmental, technological, policy, regulatory and social aspects. Economically, recycling not only creates jobs and tax revenues, but also significantly impacts certain industrial sectors. From an environmental perspective, recycling plays an important role in conserving non-renewable resources and reducing pollution.

Technological innovations in recycling, such as the use of smart bins and biodegradable plastics, are further increasing the efficiency and sustainability of the recycling process. From a policy perspective, a good regulatory framework, such as in the Philippines, helps ensure

that recycling practices are implemented in a sustainable manner. The social aspect is also important, where society's attitudes and practices towards recycling continue to develop, although improvements in waste management are still needed.

Overall, this research emphasizes the importance of synergy between economics, technology, environment, policy and social dynamics in creating a more effective and sustainable recycling system. These findings are very useful for policymakers, businesses and society in their efforts to advance sustainable and impactful recycling practices.

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CONFLIC OF INTEREST STATEMENT

There are no conflicts of interest to declare

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