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Original Article

Environmental Sustainability through Circular Economy Models

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ABSTRACT

The increasing environmental damage caused by the traditional linear "take–make–dispose" model has led to the need for sustainable economic alternatives. The Circular Economy (CE) emerges as a transformative approach that separates economic growth from environmental harm by promoting resource efficiency, recycling, remanufacturing, and closed-loop systems. Rooted in concepts like cradle-to-cradle design and industrial ecology, CE integrates renewable energy, digital technologies, and sustainable materials. Environmental sustainability in CE is measured using indicators such as carbon footprint reduction, material circularity, energy efficiency, and water reuse. Analytical tools like Life Cycle Assessment (LCA) and Material Flow Analysis (MFA) help evaluate its impact. Case studies across industries show significant benefits, including up to 30–70% reduction in emissions, over 80% waste reduction, and improved resource productivity. Despite these advantages, challenges such as regulatory, financial, and behavioral barriers remain. A successful transition requires coordinated efforts in policy, innovation, and stakeholder collaboration. Overall, the circular economy plays a vital role in enhancing environmental sustainability and supporting long-term economic resilience.

KEYWORDS

Circular Economy, Environmental Sustainability, Lifecycle Assessment, Material Flow Analysis, Resource Efficiency, Waste Valorization, Carbon Emission Reduction, Sustainable Development.

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1. INTRODUCTION

1.1. Background

Green sustainability has become one of the most urgent global problems of the XXI century due to the acceleration of the industrialization process, uncontrolled urbanization, and an ever-growing population. In the last 50 years the world has been mining the natural resources three times more and this has exposed the systems and earth limits in a way that has never been experienced before. The escalated pressure on the raw materials, energy and land has not only exhausted the available finite resources but has also caused a lot of pollution and environmental degradation. Recent international environmental audits have shown that coverage of resources extraction and processing contributes to the emission of almost a half of the total of greenhouse gases and over 90 percent of the loss of biodiversity across the world. Such effects are further enhanced by linear production and consumption interactions which give preference to short term economic benefits other than long term ecological stability. This has led to climate change, habitat destruction, water shortage, and piles of waste that are intertwined crises, which need systemic change urgently. The solution to these issues requires new economic approaches and sustainable economic systems that would decrease environmental costs but boost economic growth and social welfare.

1.2. Need for Environmental Sustainability

The sustainability of the environment is needed to be in place so that the current development needs are effectively met without jeopardising the powers of the future generation to satisfy their needs. It involves a harmonious combination of environmental conservation, economic development as well as social welfare. In contemporary economies, sustainability is required in several important dimensions.

Fig 1 - Need for Environmental Sustainability

1.2.1. Carbon Neutrality

Carbon neutrality is defined as having equal emissions of greenhouse gases and eliminating or compensating emissions into the atmosphere. Since climate change is increasing with the excessive carbon emissions through burning fossil fuel, industrial processes and deforestation, there is urgent need to switch to low-carbon systems. Some of the actions that can be taken to ensure carbon neutrality are the utilization of renewable energy sources, energy efficiency, carbon capture technologies, and sustainable transportation. This aspect is the key to curbing global temperature increase and fulfilling global climate obligations.

1.2.2. Resource Efficiency

Resource efficiency is concerned with the maximization of value of natural resources and reducing wastage as well as causing less harm to the environment. Having limited raw materials and rising demand at the global level, the resources must be used efficiently to decrease depletion and ensure long-term supply. The strategies should include optimization of materials, recycling, sustainable sourcing and process innovation, which will lead to improved productivity and reduce ecological pressure. Economic resilience also becomes enhanced through better efficiency in resource utilization by limiting reliance on limited inputs.

1.2.3. Waste Minimization

Waste minimization is meant to minimize the level of waste produced during the production and consumption processes. Overproduction of waste also leads to land degradation, pollution and release of greenhouse gases. Waste may be highly reduced by encouraging reuse, recycling composting and sustainable product design. Waste reduction also safeguards the ecosystems as well as preserving valuable resources of materials and energy contained in the products.

1.2.4. Ecosystem Restoration

Ecosystem restoration entails rehabilitation of deteriorated natural environments in order to replenish biodiversity, soil and water structures. The ecological balance has been distorted seriously by industrial activities, deforestation and urbanization. Restoration efforts including reforestation, wetland restoration and sustainable agriculture contribute to the re-establishment of the natural capital and the resilience of the environment. Healthy ecosystems also offer important services such as carbon sequestration, water purification and control of climate.

1.2.5. Renewable Energy Synergy

The integration of renewable energy focuses on the shift of fossil fuels to clean energy like solar, wind, hydro and biomass. Green power lessens carbon emissions, decreases air pollution as well as increasing energy security. The introduction of renewables into national grids and industry systems would facilitate sustainable economic development and reduce environmental risks. This transformation is central in attaining long term environmental sustainability objectives.

1.3. Environmental Sustainability through Circular Economy Models

Circular Economy (CE) models can contribute to environmental sustainability by a significant margin because they are designed to separate the economic growth and the depletion of resources and environmental degradation. The circular economy encourages a regenerative economy where materials and products are retained in use as long as possible unlike in the traditional linear model where extraction, production, consumption, and disposal occur. With its focus on reuse, repair, remanufacturing, and recycling strategies, CE will decrease the necessity of virgin raw materials and thus decrease the production of waste. Such transition does not only save the finite natural resources but also reduce the emission of greenhouse gasses used during extraction and primary production processes. The models of the circular economy incorporate the lifecycle thinking into design and industrial processes. Development of products is done keeping in mind that products shall be made to be durable, modular, and recyclable such that materials used could be retrieved and used again in production processes. This will help in maximizing resource effectiveness and minimize environmental impacts in the value chain. Also, circular systems promote the use of renewable energy sources and cleaner production technologies, which lead to the further reduction of carbon intensity and environmental pollution. In addition to the material efficiency, CE models can help to preserve the ecosystem by decreasing landfills, minimizing the pressure of resource extraction, and avoiding destructive emissions. Natural ecological processes also resemble closed-loop systems where the waste produced by one process can be used as input to another process, producing repetitive and regenerative systems. Another aspect of business practice that is encouraged by this model is product-as-a-service business models and shared consumption platforms, which minimize overproduction and wasteful consumption. The circular economy has provided a viable way forward towards sustainable development by linking the environmental goals to value generation, thereby creating an economy that is sustainable. It enables climate reduction, security of available resources and resilience over time and not compromise productivity and competitiveness. Finally, circular economy frameworks constitute a system solution that can help to solve the related issues of the environment in an interdependent system and foster a sustainable future.

2. LITERATURE SURVEY

2.1. Evolution of Circular Economy Theory

The Circular Economy (CE) concept has been formed by incorporating the various frameworks of sustainability. The concept of industrial Ecology presented the fact that industrial systems could be structured like a natural ecosystem with the result of one process being an input to another, thus reducing wastes. Cradle-to-Cradle Design took this further by advocating product systems where materials are developed to undergo endless cycles of reuse, either as biological nutrients which can safely go back to nature or as technical nutrients that can go around the industrial systems. Biomimicry also enhanced the theoretical foundation by promoting innovative thinking based on the natural processes that are efficient and produce no waste. The Performance Economy added the change in the ownership of products to models of the service which underlined durability, maintenance, repair, and reuse. The combination of these views formed CE as a regenerative economic approach that seeks to untether economic growth to consumption of resources and destruction of the environment.

2.2. Lifecycle Assessment in Circular Systems

Lifecycle Assessment (LCA) is a key factor in assessing the environmental performance of the circular system. It helps to study environmental effects in the entire lifecycle of a product such as raw material mining, production, delivery, product usage, and disposal. Circular systems LCA is used to measure the energy, greenhouse gas, water, and material depletion saved by strategies like recycling,

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remanufacturing and extending the life of products. Studies always indicate that circular solutions can lower the total lifecycle emissions in comparison with conventional linear models of take-make-dispose. Nonetheless, precise LCA in cyclical situations must entail a cautious system boundary delimiting, recycled resources allocation and rebound effects taking into account to have credible and comparable outcomes.

2.3. Material Flow Analysis

Material Flow Analysis or MFA is a statistical tool applied in the process of estimating the flow of materials within economic systems, whereby inputs, stocks and outputs are measured within specific limits. Applied in the framework of Circular Economy, MFA can be used to evaluate the efficiency of resources and the extent of their circularity by determining the percentage of materials that are recycled, reused or recovered out of total material consumption. An increase in circularity indicates a lesser reliance on the extraction of virgin resources and less waste. MFA is useful to policy makers and industries to show their material bottlenecks, leakage points of waste and avenues on how to integrate either closed loop. MFA aids in strategic planning of resource conservation and long-term transitions of sustainability when implemented at the national or sector levels.

2.4. Sectoral Applications

The concepts of Circular Economy have been applied to various areas where their effects can be quantified in environmental terms. Remanufacturing and refurbishment activities in manufacturing prolong the life cycles of products and save a lot on the demand of virgin raw materials and production processes that consume a lot of energy. The recycled aggregates and modular building design used in the construction industry reduces the embodied carbon and construction wastes. In electronics, the component reuse and recycling techniques are applied to the increasing problem of electronic waste and acute shortage of materials. Composting, bio-loops and regenerative farming techniques in agriculture increase soil fertility, lessens the reliance on chemicals, and aid in the restoration of the ecosystem. These industry-specific applications prove the flexibility of CE principles and also help to reduce the resources and emissions.

2.5. Research Gaps

Even though there is an increasing academic and industrial interest, there are still a number of research gaps that do not allow implementing the Circular Economy in its full-scale. A significant obstacle is that there are no standardized metrics and assessment frameworks that could be used to measure the level of circularity performance in industries and areas. The inconsistent indicators complicate the cross-sectoral comparison and complicate the process of policy development. There is also structural barriers of large-scale industrial adoption which include limits of technology, complexity of supply chain and regulatory constraint. Another issue is the economic viability especially when options of long-term trade-offs in costs and risks of investments are considered. Moreover, the frameworks on behavior transitions have not been well-developed since consumer acceptance, organizational culture, and collaboration between stakeholders are key factors in

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facilitating circular transitions. These gaps need to be addressed to speed up the transition to a regenerative and sustainable economic model.

3. METHODOLOGY

3.1. Research Design

The study employs a mixed-methodology that incorporates the analysis tools of qualitative and quantitative measures aimed at assessing the performance of the circular economy. The combination of environmental evaluation methods and performance measurement frameworks will make the study systematic and data-driven in estimating circular strategies in the selected sectors. The combination of Lifecycle Assessment (LCA), Material Flow Analysis (MFA), Sustainability Performance Indexing, and Comparative Benchmarking allows to get a multidimensional perceiving of environmental, material, and operating impacts.

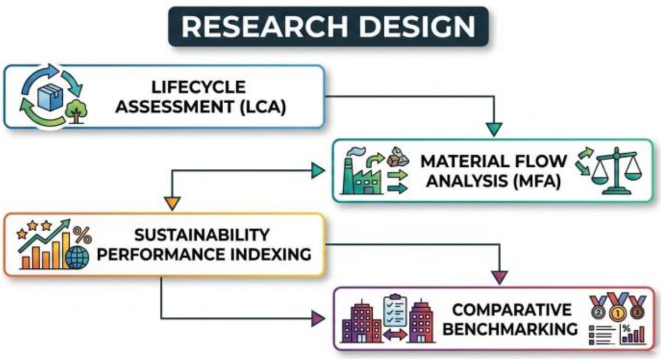

Fig 2 - Research Design

3.1.1. Lifecycle Assessment (LCA)

Lifecycle Assessment is the method deployed to measure the environmental effects of all the phases of a product or system, including the extraction of raw materials, to the end of life treatment. In this study, LCA analyzes energy usage, the greenhouse gases, and resource utilization in both linear and circular conditions. This will make comparative evaluation of environmental performance possible and aid in determining the phases in which circular interventions yield the highest environmental burden reductions.

3.1.2. Material Flow Analysis (MFA)

MFA is used to measure the flow of materials within the firm system boundaries. It quantifies the inputs, outputs, recycling rates and waste production to ascertain the level of circularity. The study, using MFA, establishes the efficiency of resources, material wastage, and possibilities to bridge material loops. This quantitative study will be useful in making strategic decisions to maximize resource utilization and reduce the reliance on virgin material.

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3.1.3. Sustainability Performance Indexing

To bring together various environmental and resource indicators into a systematic assessment system, sustainability Performance Indexing is used. Various measures are used to compute this index including emission intensity, recycling, energy efficiency, and material productivity to get a sustainability score. The indexing method enables a simplified comparison of sectors and scenarios with an analytical rigor of assessing the performance of the circular economy.

3.1.4. Comparative Benchmarking

The use of Comparative Benchmarking allows the evaluation of the performance of the circular systems against the conventional linear models or industry best practices. Through the analysis of key performance indicators in case studies or industry, the study can determine area gaps in performance, most effective strategies, and scalability opportunities. This is the best way of making the study more practical as by identifying the analytical results with real-world implementation standards and policy targets.

3.2. Analytical Framework

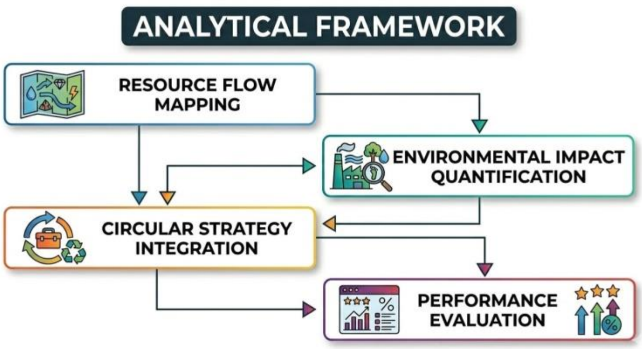

Fig 3 - Analytical Framework

3.2.1. Resource Flow Mapping

The initial move is to map out the flow of resources of the specified system systematically. This involves the determination of raw material feeds, energy use, manufacturing, distribution of products, their use and disposal. Resource Flow Mapping gives a clear visual impression of the streams of materials, waste generation and recycle loops. Through the knowledge of materials flow, it is possible to locate inefficiency and leakage areas, which are the basis of circular intervention strategies.

3.2.2. Environmental Impact Quantification

Here, the environmental effects of every phase of the charted resource flows are measured. The important indicators like green house gases, energy consumption, water usage and waste production are measured through the help of suitable assessment tools. The process will allow assessing environmental hotspots in the system and identifying the stages with the greatest ecological cost. Using impacts as a metric gives an objective foundation on improvements to be made and to compare the linear and the circular situations.

3.2.3. Circular Strategy Integration

As soon as the environmental hotspots and material inefficiencies are detected, appropriate circular strategies are applied to the system model. Such strategies can be recycling, remanufacturing, product life, resource substitution, or closed-loop supply chains. The integration stage considers the way these interventions change level of material flows and minimize environmental impacts. This is a process of converting the theoretical circular principles into practical, system level changes that can be evaluated in terms of effectiveness and feasibility.

3.2.4. Performance Evaluation

The last stage evaluates the general functionality of the system following the adoption of circular strategies. This analysis compares the key performance indicators prior to integration and after integration to identify the progress in resource efficiency, emission reduction, and sustainability performance in general. Economic and operational implications are also included in Performance Evaluation to make sure that it will be practicable. The findings present evidence-based information about the efficiency of the circadian interventions and inform decision-making based on the evidence to change the system on a lasting basis.

3.3. Sustainability Indicators

The sustainability indicators give quantifiable standards to measure the environmental performance of the circular economy initiatives. The Carbon Reduction indicator is calculated as a percentage of reduction of the carbon emission through the conversion of the conventional linear system into a circular system. It takes the baseline emissions and the emissions after the application of circular strategies under the linear model, and puts it as a percentage. The indicator is vital in the evaluation of the contribution to climate mitigation and with the global carbon neutrality goals. Waste Diversion is the ratio of the total waste that is diverted out of landfills or burning by recycling, re-using or recovering. In the form of a percentage, it shows the efficiency of waste management systems and the extent to which material loops are effectively closed. An increase in waste diversion rates signifies a greater level of circular performance and a face in disposal. Energy Efficiency is a measure of the useful energy output to the total energy input in a given system. This indicator measures the efficiency of the conversion of energy resources into productive outputs, instead of just measuring the energy consumption. Greener energy efficiency implies more efficient production methods, less energy wastage and operational emissions. In circular systems, remanufacturing, optimisation of processes, and integration of renewable energy are often used to improve the energy efficiency of such systems. Water Reuse rate is given as a percentage of total water consumed and treated and reused in the system. The indicator is especially significant within the water-intensive industries like manufacturing and agriculture. An increase in the rate of water reuse proves efficient water management, the decrease in freshwater abstraction, and resistance to water shortage. Collectively, the four indicators provide a holistic system of gauging the sustainability of the

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environment. The framework allows measuring the implementation of the circular economy in a multidimensional manner by incorporating carbon performance, waste management efficiency metrics, energy performance, and water savings in the framework to allow assessing the achievement of sustainability advancement across industries uniformly.

4. RESULTS AND DISCUSSION

4.1. Environmental Performance Improvements

A shift toward a more advanced model of a circle type of an economy leads to a considerable positive difference in the performance of the environment on a number of levels. The decrease in carbon emissions is also one of the most important benefits. In the linear systems, greenhouse gasses are produced in large quantities by the process of extracting virgin raw materials, manufacturing that is energy intensive and by the use of landfills or incineration as waste disposal methods. In contrast, as circular systems, they are placing more emphasis on recycled and secondary material which generally uses much less energy to process compared to virgin resources. The net effect of this decrease in extraction and primary production activities is the reduction of total carbon footprints and a contribution to the mitigation of climate change goals. Performance in waste management is also significantly enhanced in the case of circular implementation. Circular systems focus on reuse, repair, remanufacturing and recycling instead of a take-make-dispose model. Through these strategies, huge amounts of waste have been prevented in landfills and incinerators thus mitigating environmental contamination, methane and land use pressures. The increased rate of waste diversion points to the efficient material recovery systems and more resource-efficient systems. The use of remanufacturing and product life extension also reduces the energy consumption. Remanufacturing conserves the introductory energy in products by refurbishing the products back to service instead of creating new products out of raw materials. This process can be something that consumes a third of the energy used in primary production. Also, it is common that circular systems incorporate cleaner production technology and renewable energy sources, which improve the overall efficiency of energy. Apart from benefits in carbon, waste, and energy, Circular models also lead to a decrease in water consumption, decrease in resources depletion, and decrease in disruption of the ecosystem. Circular systems achieve a regenerative structure that improves the sustainability of the environment by stopping the loops of materials and streamlining the production-consumption cycle, which does not sacrifice economic productivity. In general, circularity transition illustrates quantifiable and transformative environmental benefits over linear constructs.

4.2. Performance Comparison

Table 1: Performance Comparison

Sustainability Metric	Linear Model (%)	Circular Model (%)	Improvement (%)
Carbon Emission Reduction	0	45	45
Waste Diversion Rate	20	85	65
Resource Efficiency	50	80	30
Energy Savings	10	55	45
Water Reuse	15	60	45

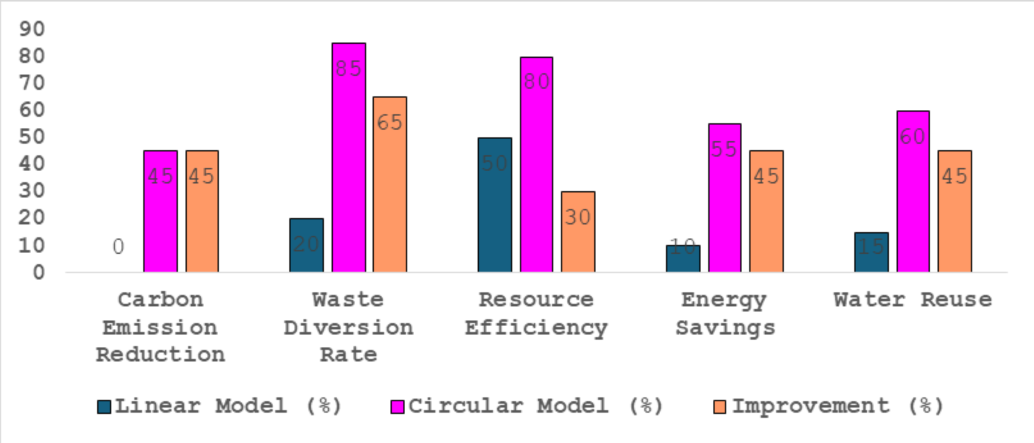

Fig 4 - Performance Comparison

4.2.1. Carbon Emission Reduction (45%)

The statement that carbon emission has decreased by 45 percent shows that climate performance is dramatically improved under the circular model. This has been significantly done through the reduction of the primary manufacturing which involves extensive use of energy and the enhancement of its waste management. Through recycling and remanufacturing, the system reduces considerably the green house gases that are generated during processing of raw materials and disposal. This kind of reduction has a positive effect on the decarbonization goals and is helpful to meet the international climate reduction policies.

4.2.2. Waste Diversion Rate (65%)

The 65 percent increase in the waste diversion indicates a high shift of the present disposal-based practices towards recovery-oriented systems. A high percentage of materials that are meant to be disposed of in landfills or burning plants are brought into the mainstream of production through increased reuse, recycling and remanufacturing. The diversion rate is high to minimize pollution of the environment, save space in landfills, and decrease the emission of methane gases by decaying wastes. It also shows the efficiency of collection systems and reverse logistics infrastructure.

4.2.3. Resource Efficiency (30%)

Growth in resource efficiency by 30 percent denotes better use of materials during the production and consumption process. This has been increased by improved methods of production, lessening of wastage of materials, and any other second-hand materials in favor of virgin materials. An increase in resource efficiency implies that a greater amount of economic value will be created on every unit of resource consumed, which contributes to the long-term growth as well as reduces the environmental burden. It also eliminates the vulnerability of supply chains associated with the shortage of raw materials.

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4.2.4. Energy Savings (45%)

The possibility to save 45 percent of energy illustrates the efficiency of the remanufacturing, optimization of the processes, and renewable energy integration as the examples of the circular strategies. The circular system greatly decreases the total energy demand by preserving the dormant energy within current products and eliminating extraction and processing processes that require substantial amounts of energy. This does not only reduce costs of operation but also limits related emissions and effects on the environment.

4.2.5. Water Reuse (45%)

The fact that there is an increase of water reuse (45 percent) implies an enhanced water management and recycling within the system. The treated wastewater will be reused in production thereby decreasing fresh water extraction. This boosts resistance to water shortage, reduces wastewater release, and also promotes more sustainable use of resources especially in water-consuming sectors.

4.3. Discussion

These findings show clearly that the implementation of the circular economy leads to a great improvement in the environmental sustainability in various dimensions of performance. The carbon reduction, waste diversion, resource efficiency, energy savings and water reuse demonstrates collectively systemic benefits of the transition to a linear to a circular model of production and consumption. Of these indicators, the waste diversion shows the most significant improvement which is associated with the efficiency of organized material recovery systems, reverse logistics networks, and recycling infrastructure. Reducing landfill and reusing materials in the production cycles, circular systems have been shown to reduce the level of leakage into the environment and increase the value of resources in the form of their retention. Reduction of emission of carbon is closely associated with the lower reliance on the virgin material extraction and incorporation of the renewable energy into the production process. Resource loops, remanufacturing, and secondary material substitution reduce the carbon intensity of industrial activities quite substantially. This trend is also strengthened by energy saving in that, the conservation of energy in products would mean that primary manufacturing which consumes a lot of energy is not necessary. Both of these outcomes underscore the environmental and operational synergy that is achieved by circular strategies. These encouraging results notwithstanding, there are a number of systemic challenges that need to be overcome in order to guarantee scalability and a high rate of adoption. Recycling plant, reverse logistics program, and new technology installation involve high start up costs in infrastructure and this limits business, especially small and medium sized companies. There can also be regulatory misalignment and unequal policy frameworks in different regions, which can prevent effective implementation. Also, the demand of secondary materials in the market should be enhanced to sustain the economical viability. All these issues can be overcome through a combined policy, financial incentives, technological advancement, and cooperation among stakeholders. These structural obstacles need to be tackled in order to achieve a shift in pilot-scale achievements to all-encompassing, large-scale circular e environmental improvements.

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5. CONCLUSION

This paper will show that the concept of the circular economy (CE) models offers a viable and transformational way to attain the long-term environmental sustainability. The circular framework addresses the classic linear take-make-dispose system by adopting the principles of lifecycle thinking, resource optimization, and regenerative design that allow developing a closed-loop system with minimal wastes and maximum value retention. With the utilization of analytical systems, including Lifecycle Assessment and Material Flow Analysis, the study proves the existence of the beneficial effect of circular strategies to minimize the environmental burdens at the various stages of production and consumption. The circular approach is based on end-of-life waste management, but instead of emphasizing only on end of life, it incorporates sustainability throughout the design, production, use, and recovery stages to make the system efficient and resilient. The quantitative results point out objective and significant improvements in the environment. The reduction of carbon emissions is significantly high, as there is a reduced dependence on extractions of virgin material, improved recycling of materials, and a mixture of renewable energy sources. The rate of waste diversion also grows dramatically when the materials are reused, remanufactured, and recycled into production processes rather than being disposed of. The conservation of embedded energy in products and optimization of industrial processes are also shown by energy efficiency gains. Together, these results prove that the circular implementation does not only reduce the negative impact on the environment but also enhances the resource safety and the efficiency of the operations. Notably, the research supports the need to shift the current linear forms of production to regenerative circles to achieve the sustainability goals of the world. Environmental issues like climate change, resource depletion and pollution demand systemic solutions and not marginal efficiency increase. The models of circular economies mitigate these issues by achieving a separation of economic growth and resource depletion and environmental degradation and pursuing sustainable development goals. Going forward, the study on how digital enablement technologies (artificial intelligence, blockchain, and Internet of Things (IoT) systems) can improve the process of material traceability, reverse logistics optimization, and circular supply chain coordination will be explored. Circular business models (such as product-as-a-service and shared economy platforms) development also needs further research to determine the economic sustainability. In addition, global harmonization of policies and standardized circular performance indicators are necessary to increase the rate of adoption. The scale of developing these areas will be of critical importance in order to reach a regenerative and sustainable global economic system that is practiced on a circular economy.

REFERENCES

[1] Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308–320.

[2] Braungart, M., & McDonough, W. (2002). Cradle to Cradle: Remaking the Way We Make Things. North Point Press.

[3] Ellen MacArthur Foundation. (2013). Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition. Ellen MacArthur Foundation.

[4] Ellen MacArthur Foundation. (2015). Growth Within: A Circular Economy Vision for a Competitive Europe. Ellen MacArthur Foundation.

[5] Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for manufacturing. Scientific American, 261(3), 144–152.

ISSN: 3071-5636
PP: 01-13.

[6] Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production, 143, 757–768.

[7] Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on Circular Economy: The expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11–32.

[8] Graedel, T. E., & Allenby, B. R. (2010). Industrial Ecology and Sustainable Engineering. Pearson Education.

[9] Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the Circular Economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232.

[10] Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The concept and its limitations. Ecological Economics, 143, 37–46.

[11] McDonough, W., & Braungart, M. (2002). Design for the triple top line: New tools for sustainable commerce. Corporate Environmental Strategy, 9(3), 251–258.

[12] Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics, 140(3), 369–380.

[13] Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the Circular Economy in China: Moving from rhetoric to implementation. Journal of Cleaner Production, 42, 215–227.

[14] Tukker, A. (2015). Product services for a resource-efficient and circular economy: A review. Journal of Cleaner Production, 97, 76–91.