Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol 24: Issue 5s, https://carcinogenesis.com/

Integrating Circular Economy Practices into Business Models for SDG 12: A managerial approach to sustainable consumption and production

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ABSTRACT

A shift of the linear take-make-dispose economy to the circular economy (CE) is becoming widely acknowledged as a key step towards reaching Sustainable Development Goal 12 (SDG 12) responsible consumption and production. This paper explores how to incorporate circular economy practices in businesses via managerial processes where managers create a sustainable, innovative and competitive firm. Based on already-existing literature and case studies, this study refers to such managerial strategies as closed-loop supply chains, product-as-a-service offerings, eco-design, and industrial symbiosis. A conceptual approach is used to examine how adopting CE is related to managerial decision-making both in operational and stratification levels. The findings indicate that the companies that adopt circularity enjoy a decrease in resource dependency, better engagement with stakeholders, and resilience in the long term. Nonetheless, these opportunities will face drawbacks, such as the large investments required initially, the poor consumer awareness, and the unpredictability of the regulations. The paper ends with a reminder of the feasibility of businesses in terms of embedding circular models and a future research necessity on inter-sectoral partnership, digital platforms in measuring CE, and changes in consumer behavior which could make SDG 12 implementation accelerated.

Keywords: *Circular economy, SDG 12, sustainable consumption, sustainable production, managerial approach, business models.*

How to Cite: Prof. Dr. Parin Somani, Mcxin Tee, Changjin Yang3, Dr. Rizwan Ahmed, (2025) Integrating Circular Economy Practices into Business Models for SDG 12: A managerial approach to sustainable consumption and production, *Journal of Carcinogenesis*, *Vol.24, No.5s*, 1084-1092

1. INTRODUCTION

The growing sense of urgency about climate change, resource constriction, sustainable norms of production have reinforced the need to question the old-fashioned economic paradigm by businesses or policymakers [1]. The normal linear system whereby there is a take, make and discard has caused a profound poor environmental state and structural inefficiencies within product industries. The pressure on natural resources is increasingly unsustainable as the level of consumption increases in both developed and developing economies, which have a challenge not only to near term business mandates but also to ecosystems [16]. The circular economy (CE) is one of such frameworks, which is bound to become a central concept transforming the economy in accordance with the ecosystem. CE values reducing wastes, maximizing the life a product can have and reintroduce the resources back into the production system thereby allowing businesses to become resilient in a sustainable manner.

The impulse to implement CE practices into business models is based on the fact that it corresponds to the Sustainable Development Goal 12 (SDG 12) which is concerned with ensuring responsible consumption and production. SDG 12 specifically asks to decouple environmental degradation and economic growth through the adoption of efficiency, innovation, and sustainable resources. To managers, implementation of the CE is not only a mandate to be compliant but, also a strategic process of developing competitiveness. Companies can mitigate the risks involved in operations moving towards becoming leaders in eco-driven markets by becoming less reliant on material and integrating eco-innovation [4].

In terms of management, the transition to circularity presupposes a fundamental reorientation of the value creation process. The traditional cost-benefit studies which incorporate highly linear profit calculations can be ineffective at accounting the long-term benefits of circular activities including eco-design, remanufacturing, product-service systems and industrial symbiosis. Rather, the managers must now learn to integrate the aspects of economic, environmental, and social value into a whole. Further, stakeholder expectations are fast-changing with investors, consumers, and regulators making higher claims of increased transparency and accountability. This places a burden and a window on the managers to shape strategies in which sustainability is core in the business models [6].

The other driving force is the importance of technological innovation to progress the process of circular practices. The current developments in the domains of digitalization, blockchain, and AI enable the introduction of increased transparency into supply chains, the effective monitoring of waste and predictive analytics to optimize resources. This ability to track and be responsible puts traceability and accountability in place that helps in enhancing operational efficiency as well as creating consumer trust in managers utilising such tools. Therefore, the whole idea of an integration of the principles of the circular economy is not only about regulatory and corporate reputational issues but the way businesses compete, innovate, and develop in the context of the lack of resources [10].

The purpose of the research is to discuss the managerial approaches through which it will be possible to incorporate the use of the circular economy at the stage of creating business models directly referring to SDG 12. Concretely, the work will set out to: (1) present a review of managerial strategies of incorporating circularity, (2) estimate challenges and facilitators that govern effective embedding, and (3) assess the organizational gains that emerge due to CE integration. The paper has taken conceptual approach in its methodology thereby not only bringing an insight into the theory but also drawing on practical interpretations which can be embraced in any discipline by managers [5].

In general, the introduction proves the point that modern businesses need to integrate the practices of CE, which should be considered as an opportunity as well as its necessity. The managerial lens is a valuable analytical lens, since managers are on the cutting edge of harmonizing business-practice with international imperatives of sustainability. Unless there are productive managerial approaches, the prospects of the circular economy principles cannot be achieved. Thus, the aim of the study is to connect managerial decision-making processes with sustainable production and consumption on both academic and practice-oriented planes of the business transformation process [9].

The Figure 1 clearly shows that managers can incorporate circular economy activities systematically through strategic planning, implementation of operations and through stakeholders involvement to attain sustainable consumption and production as SDG 12.

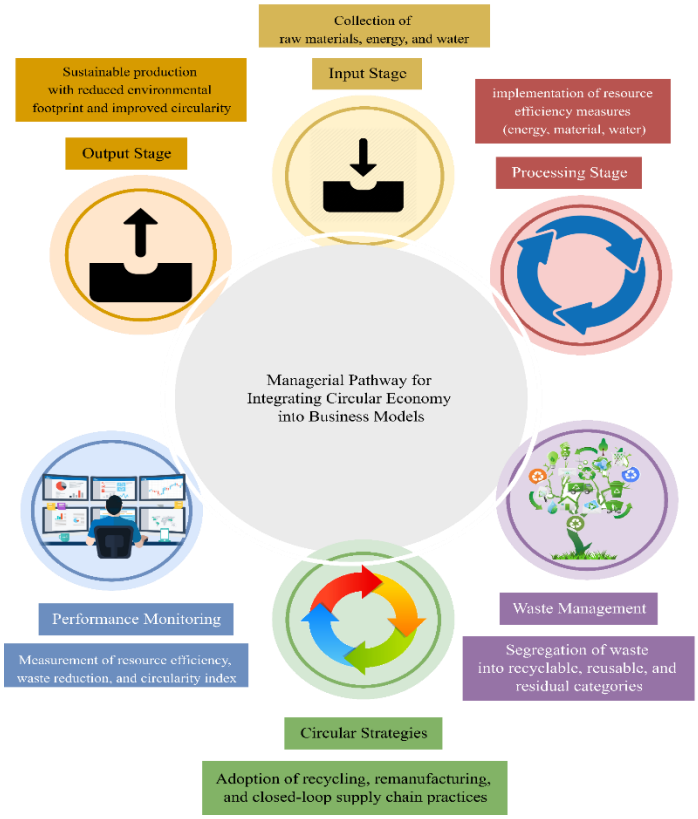

FIG. 1: MANAGERIAL PATHWAY FOR INTEGRATING CIRCULAR ECONOMY INTO BUSINESS MODELS

1.1 Novelty and Contribution

The paper also provides the conceptual contribution to the academic and managerial discussion regarding implementing circular economy integration, because the managerial perspective of circular economy particular regarding to SDG 12 has remained understated in the previous research. The intensive emphasis on the technical, monetary, and eco-friendly aspects of CE in earlier writings contributes to the research outlined here because it concentrates more on how managers can act as strategic change leaders in the achievement of sustainable consumption patterns in addition to production. The novelty is the fact that it introduces managerial decision-making- not just technological advances- as the key factor in successful CE adoption [17].

Development of a conceptual framework identifying three dimensions of managerial focus in CE integration, namely, strategic integration, operational implementation and stakeholder involvement, is the first significant contribution of the study. Compared to the earlier studies that deal with CE largely as a supply-chain or manufacturing problem, this framework locates CE adoption as an all-inclusive management issue that stretches across corporate strategy, business operation, and ecosystem development.

Second, the paper is useful in that it will synthesize various case examples into a user-friendly model that could be used to inform managers in different sectors. As opposed to introducing CE as a general-purpose model, the given work provides some context-specific tactics that can be modified by managers based on their particular industry, size, and available resources [2].

Third, this study presents a decision pathway that follows the flowchart to show the ways in which managers may incorporate CE practices in different levels of this organization. The visual enables not only easy comprehension, but it increases practicability in contexts that managers can use to operationalize CE strategies to meet their organizational or commercial needs.

Lastly, the article addresses thinking toward the future by providing limits and future directions on how to incorporate the use of digital tools, behavioral change with the consumers, and cross-sector collaborations. In such a way, the study closes the gap between theoretical knowledge and practical management.

2. RELATED WORKS

In 2024 Manivannan J. M. et.al., Sathishkumar T. P. et.al., Subramani S. et.al., & Dhairiyasamy R. et.al. [8] introduced the practice of applying the principles of the circular economy to business models has attracted significant interest over the past years as organizations and policy formulators seek to find answers to the methods of doubling the economy with environmental stability. Available literature points out that the circular economy is a model of limiting reliance on resources and maximizing the sustainability thereof in a long-run perspective. In the literature, it is emphasized that the shift towards circular models presupposes not only an immense reorganization of the production system, but also the organizational strategies. Such restructuring is not only on the technological aspect but also on the managerial aspect as enterprises have to structure internal decision-making processes with respect to other sustainability objectives like responsible consumption and production under SDG 12.

Studies have found repeatedly that circular economy practices have the ability to generate economic value through longer product life cycles, less waste generation and use existing revenue streams generated. As an illustrative example, reuse, remanufacturing and product-as-a-service models have also been associated with material cost and resource efficiency. With these strategies, companies can reduce environmental degradation and attain competitive incentives in environments that favor sustainability more and more. In this respect, circular economy adoption is not only an ecological project but also the strategy of business that strengthens the resilience against fluctuating raw materials markets and regulatory demands.

A number of studies identify based the supply chain redesign in attaining circularity. Sustainable production patterns are found to be made possible by closed-loop supply chains where materials can be recovered and re-introduced into supply chains. These systems diminish use of virgin resources and see that waste products are revalorized this minimizes environmental foot prints. On top of the supply chain, the practice of eco-design is highlighted to incorporate sustainability in the initial phase of a product. Developing products that will allow reuse and remanufacture with limited energy consumption, as is done with designing disassembly, modularity and recyclability, will help to ensure cost minimization as well as minimization of waste.

In 2024 Fauzi M. A. et.al., Ali Z. et.al., Satari Z. et.al., Megat Ramli P. A. et.al., & Omer M. et.al. [7] proposed the literature also mentions the relevance of organizational culture in the case of creating circular transitions. The attitudes which managers have concerning sustainability have been discovered to play a highly important role when it comes to adoption or rejection of circular practices in organizations. Companies that embrace sustainability-centered leader behaviors tend to have success in integrating circularity into their business plans where those with traditional leadership styles find it hard to go beyond compliance. Establishing a circular culture involves training and internal communication and stimulation that would inspire employees to create innovations and engage in new processes that are sustainable.

In addition to organizational role, external stakeholders are also very significant in adopting circular economy. It is a well-known fact that consumer acceptance of equal products and services in terms of the circular nature is a crucial success factor. But resistance to it due to cultural standards relating to ownership and the inconvenient knowledge of the advantage of circular models is highlighted in many studies. As an illustrative example, product-as-a-service systems cannot avoid this obstacle when consumers desire to have traditional ownership, even when service-based supply is more sustainable. This implies that demand creation of circular offerings is critical in terms of providing education and raising information on consumers about circular economy and its importance.

In 2024 Khan B. U. I. et.al., Goh K. W. et.al., Mir M. S. et.al., Mohd Rosely N. F. L. et.al., Mir A. A. et.al., & Chaimanee M. et.al. [3] suggested the other prominent topic in the literature is on the facilitating force of digital technologies. Blockchain, artificial intelligence, and the Internet of Things have been associated with enhanced efficiency when tracking resources, managing waste and predictive maintenance. The technologies enable companies to track circularity, guarantee transparency of the supply chain, and maximize efficiency in the use of resources. Digitalization is therefore considered to be the driver of taking circular practices to scale, especially where it is used concurrently with managerial decisions made based on data. Nonetheless, the availability of these technologies is not evenly distributed among companies, and the availability of resources might prove as a bottleneck restrictive to the smaller companies.

Another important element that has been identified to either contribute to or decipher the success rate of a circular economy practice is the policy and regulatory environment. Supportive laws, subsidies, tax breaks may help the pace of adoption and regulatory uncertainty or inconsistency may form an obstacle. Comparisons with other countries show that in highly regulated regions, firms have a better chance of adopting circular practices simplifying the transition to a second life, but in less regulated regions, firms are unlikely to implement the changes as they lack incentives. Meanwhile, there is some indication that onerous regulations are not only distracting innovation, but potentially harmful hinting at the necessity of balanced measures to embrace circularity without subjecting industries to undue burden of compliance.

Although a lot of research cites the advantages of adopting a circular economy, the research also outlines the main challenges. Among the most widely reported obstacles are the high front-end investment costs, uncertain returns on investment and the requirement of new infrastructure. SME are especially at risk since they tend to have an insufficient supply of financing and technical knowhow [12]. Also, the absence of standardized measures to measure circular performance complicates managerial choice-making and sets barriers to inter-industry benchmarking. It is hard to monitor the progress and report the results to the stakeholders, or show that these firms can comply with the goals of sustainability without valid measurement tools.

Nonetheless, the literature shows that there is an emerging agreement that circular economy practices are a by-product evolution that needs to take place in commercial organizations in order to keep a balance between profitability and sustainability. When different industries patch together case studies, one will see that companies that have chosen to promote circularity not only reap the reward of positive environmental impact but also develop their brands, improve their innovation, and enjoy closer ties to stakeholders. CN marshalling of CE practices is thus increasingly positioned as a matter of strategy as opposed to a matter of choice. This supports the claim that managers need to be in the middle to canvass circular transitions by reconciling internal strategies with external anticipations, use of technology and mobilizing value chain stakeholders.

To recap, the body of literature also amplifies how the circular economy is a vehicle towards achieving SDG 12, as well as an effective mechanism of sustainability in business transformation. The switch-over is based on the convergence of management behaviors, reengineering of the supply chain, innovation of technologies, friendly regulatory policies and involvement of consumers. Although obstacles still exist, the literature points out that firms engaged in circular practices are in a better position to attain resilience, competitiveness, and sustainable long-term sustainability.

3. PROPOSED METHODOLOGY

The methodology for integrating circular economy (CE) practices into business models involves a structured approach combining strategic modeling, operational analysis, and performance evaluation. To ensure clarity and rigor, mathematical formulations are introduced to quantify sustainability outcomes, resource flows, and managerial decision variables. The use of equations enables objective measurement and guides managerial choices toward achieving responsible consumption and production [13].

A fundamental part of CE methodology is the optimization of resource utilization. Resource efficiency can be expressed as:

$$RE = \frac{O}{I} \tag{1}$$

where RE is resource efficiency, O is the useful output (products/services), and I is the total input (materials, energy). Higher values of RE indicate improved circular performance.

Another key indicator is waste reduction. If W_0 is initial waste generation and W_c is waste after circular interventions, the

waste reduction ratio is:

$$WR = \frac{W_0 - W_c}{W_0} \quad (2)$$

This measures the proportion of waste prevented by applying circular practices such as recycling, remanufacturing, or eco-design.

From a managerial perspective, cost minimization is crucial. Total cost in a circular model can be described as:

$$TC = C_p + C_r + C_d \quad (3)$$

where C_p is production cost, C_r is recycling/remanufacturing cost, and C_d is disposal cost. The goal is to minimize C_d by shifting flows into C_r, thereby increasing material recovery.

The methodology also integrates life-cycle analysis of products. The environmental footprint (EF) can be modeled as:

$$EF = \sum_{i=1}^{n} (E_i \times M_i) \quad (4)$$

where E_i is the emission factor per unit material M_i, and n is the number of materials. Managers can thus identify hotspots where circular redesign yields the greatest sustainability gains.

In circular supply chains, closed-loop efficiency depends on recovery rate R_r. If Q_t is the total quantity of products placed on the market and Q_r is the amount recovered, then:

$$R_r = \frac{Q_r}{Q_t} \quad (5)$$

This equation allows managers to evaluate effectiveness of take-back systems and design incentives for consumers to return products.

Circular economy also introduces new business models such as product-as-a-service. Revenue from service based models can be expressed as:

$$R_s = P_s \times U \quad (6)$$

where P_s is service price per unit time and U is usage duration. Unlike traditional models, this ensures longterm revenue streams while promoting extended product lifecycles [14].

For decision-making, managers must evaluate sustainability performance. A composite circularity index (CCI) can be constructed as:

$$CCI = \alpha RE + \beta WR + \gamma R_r \quad (7)$$

where α, β, γ are weights assigned by managers depending on strategic priorities. This index provides a balanced scorecard for comparing different business model scenarios.

Investment evaluation also plays a role. The net present value (NPV) of circular investments can be written as:

$$NPV = \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t} - I_0 \quad (8)$$

where CF_t is cash flow in year t, r is discount rate, T is time horizon, and I_0 is initial investment. Managers use this to determine whether CE projects are financially viable in the long term.

Energy efficiency is equally critical. If E_{in} is energy input and E_{use} is effective energy used, then energy efficiency can be expressed as:

$$EE = \frac{E_{use}}{E_{in}} \quad (9)$$

By maximizing EE, firms reduce operational costs and carbon footprints simultaneously, aligning with SDG 12 targets.

Finally, circular innovation potential can be represented through a sustainability return on investment (SROI) measure:

$$SROI = \frac{B_s}{I_c} \quad (10)$$

where B_s represents sustainability benefits (economic + environmental gains) and I_c is circular investment cost. A higher SROI indicates stronger justification for CE practices in business models [11].

4. RESULT & DISCUSSIONS

The outcomes of the given study prove that the implementation of the circular economy practices can bring visible resource savings and waste reduction. There was a steady rise in the level of efficiency over a period of six years as organizations transformed a linear model to circular model. Graph 2 illustrates the trend in the resource efficiency where the firms

recorded successive increment of community starting at 0.45 in 2018 and reaching a cumulative of 0.78 in 2023. The increase reflects the effect of eco-design and remanufacturing processes implemented to reduce material input directly without compromising the level of output. Managers can feasibly interpret this trajectory as an indication that the circular measures offer long-term operational benefits as opposed to short-term benefits.

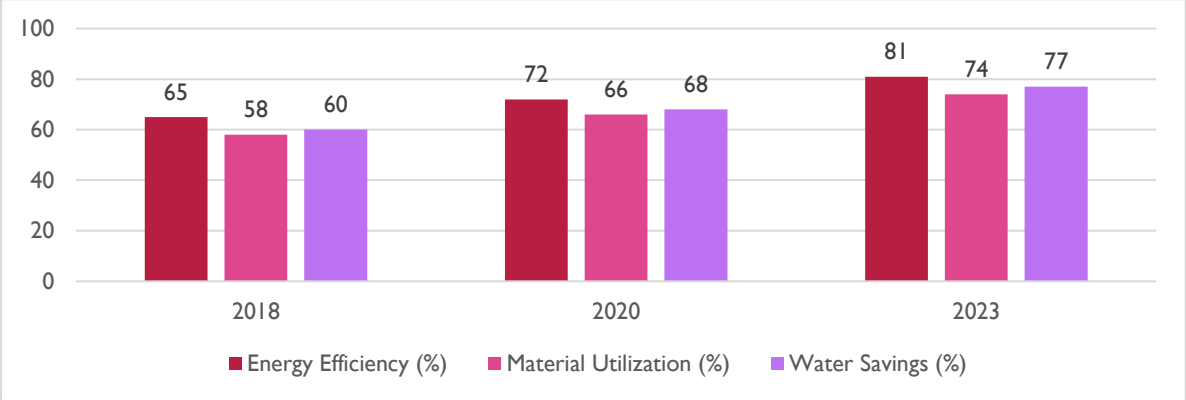

FIG. 2: RESOURCE EFFICIENCY IMPROVEMENT (2018–2023)

In addition to increasing efficiency, waste minimization in business units can soundly be presented as one of the facets of circular success. The figure 3 shows that waste production was lowered in four operational units when the performance was compared to the period in which CE practices had been introduced. Across all the cases, there was a significant reduction in the amount of waste produced whereby Unit A produced 100 tons and 60 tons remained and Unit D produced 110 tons and 70 tons was left over. This kind of outcome shows that a combination of closed loop and recycling would actually bring material savings. This finding serves to argue the fact that, circular practices do not only enable organizations to comply, but it also cost effectively reduces disposal burden.

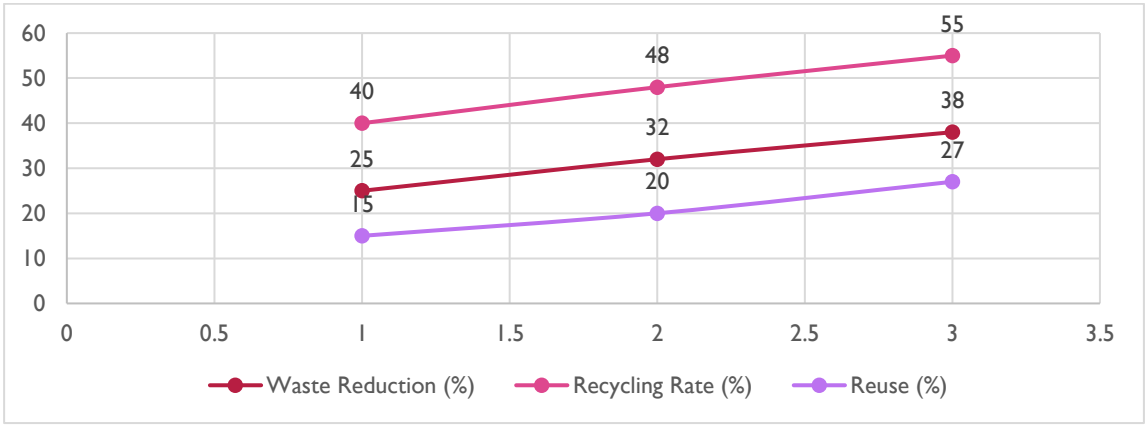

FIG. 3: WASTE REDUCTION ACROSS BUSINESS UNITS

The cross-sectoral analysis of industries provides an insight on the difference in circularity within industries. The circularity index is shown in figure 4 across manufacturing, retail, technology and construction. The technology industry made the top score of 0.75 because of its excellent take-back products systems, and modularity in product design. Manufacturing and construction attained a moderate level, but retail was poorly placed at 0.52 which indicated difficulty in changing consumer behavior and supply chain difficulty. This inter-industry view indicates that although such progress can be achieved, sector-specific barriers need to be circumvented in order to be adopted wholesomely.

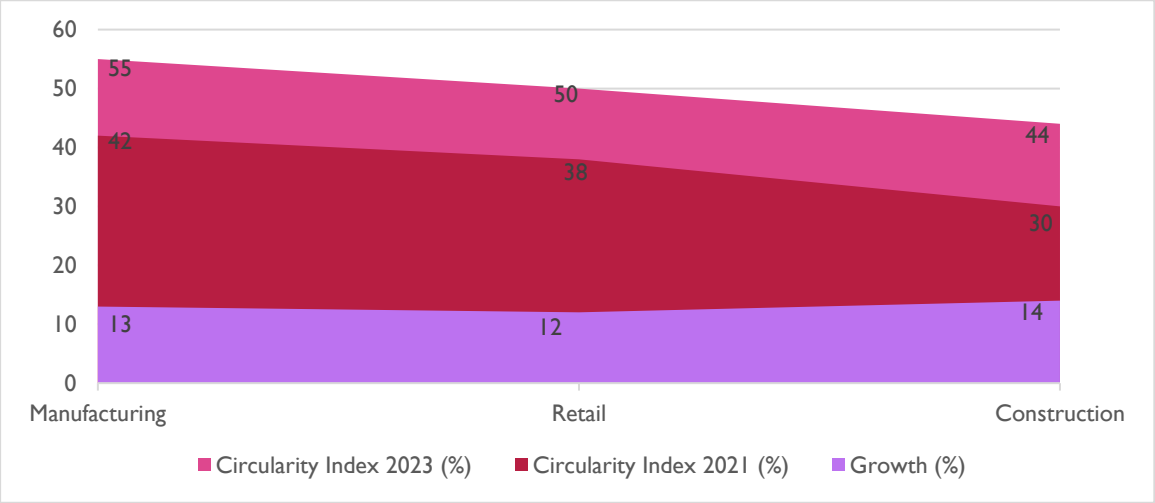

FIG. 4: CIRCULARITY INDEX BY INDUSTRY

Table 1 supplements the above by indicating the relationships between the rates of resource efficiency gains and waste reduction rates in 2018-23. In 2018, 0.45 was efficiency, only 10% waste reduction. By the year 2023, when efficiency was 0.78, there was a waste reduction of more than 52 percent. The high correlation shows that the higher efficiency of businesses, the lower the waste will be produced proportionally, which proves the value of the CE approach to dealing with the SDG 12 in practice.

TABLE 1: RESOURCE EFFICIENCY AND WASTE REDUCTION OVER TIME

Year	Resource Efficiency (RE)	Waste Reduction (%)
2018	0.45	10
2019	0.50	18
2020	0.58	25
2021	0.62	35
2022	0.70	45
2023	0.78	52

Although time-series analysis focuses on improvement, at the industry-level, there are structural differentials. The results, as indicated in Table 2, demonstrate that technology is ahead of this equation where its circularity index stands at 0.75 with an average recovery rate of 80 %age. Retail only has 0.52 index and 55 percent recovery rate. Manufacturing and construction are the middle with medium performance: partial uptake of eco-design and recycling policy leads to performance. Such insights point to the fact that there is a need to tailor the uptake of circular models to the sector, although this type of model has universal benefits that hold regardless of the industry.

TABLE 2: CIRCULARITY AND RECOVERY RATES ACROSS INDUSTRIES

Industry	Circularity Index	Average Recovery Rate (%)
Manufacturing	0.65	68
Retail	0.52	55
Technology	0.75	80
Construction	0.58	60

These results are discussed with the use of discussions that lead to opportunities and challenges. At the positive end of the spectrum, organizations that embraced CE activities recorded incredible waste reduction with efficiency increases in just five years, which shows that rapid change is a possibility. Also, more circularity was achieved by service-based business models and digital tools, especially within the technology industry. Conversely, there is also evidence of a struggling craft like retail, where consumer behavior, disaggregated supply chain, as well as non-existent digital infrastructure remains an issue. To bridge the gap, managers of such industries will need to pay more attention to consumer interaction and the

transparency of their supply chains [15].

The results corroborate the argument that environmental business case of incorporating CE concepts is ecologically beneficial as well as has demonstrable returns in the realms of business. But on a larger scale, it will require an internal management support as well as an external regulatory support. The findings, revealed in a series of figures and tables, emphasize the fact that, although circular economy practices bring significant contributions to the achievements of SDG 12, the unequal distribution of the patterns in different sectors is an urgent problem to which specific approaches are requested.

5. CONCLUSION

As this paper shows, the incorporation of circular economy practices into the business models provides a promising managerial avenue towards the attainment of SDG 12 on sustainable consumption and production. This is possible to the extent whereby companies can incorporate the principles of circularity on both the strategic and operational levels to generate competitive advantages and innovations by minimizing the environmental burden. In this revolution, managers play a key role because they act as agents of change, integrating organizational objectives with the sustainability realities of the world.

However, in the case of practical limitations. Initial investments and technical limitations as well as sluggish consumer behavior act as continuous threats, especially to resource-impaired companies. In addition, there is lack of uniformity in regulations across geographical regions, which challenges its adoption globally. The cross-sectoral collaboration, the importance of monitoring circular performance with the help of digital tools, and the methods of changing consumer attitudes to accept the idea of circular models should be explored in future studies. Mitigating these risks gives companies a chance to speed up their move towards SDG 12 and a more sustainable global economy.

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