SUSTAINABLE SUPPLY CHAIN MANAGEMENT IN A CIRCULAR ECONOMY: A REVIEW

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Abstract*—Since the middle of the 2010s, the notion of the Circular Economy (CE) has been increasingly utilized by corporations in their quest to improve environmental sustainability. In an effort to re-evaluate Sustainable Supply Chain Management (SSCM) practices, businesses have increasingly turned to the circular economy strategy. The new corporate strategy towards SSCM is made obvious by a growing but as of yet undocumented collection of literature. Seven hundred and nine publications indexed in Scopus were analyzed in this extensive evaluation of literature. There were four distinct philosophies that came to light: circular economies, sustainable supply chain management, reverse Supply Chain Management (SCM), and sustainable production and environmental management. Theoretically, SSCM is shifting in two fundamental ways due to the adoption of a circular economy strategy. First, it shifts the emphasis away from pure efficiency and waste minimization and onto the new paradigm of innovation, reuse, and product conversion in supply chain management. Second, the circular economy values and benefits from the reversal of cycles in the supply chain. This means that SCM may boost the contributions of businesses to responsible consumption and production. Based on this SCM inside a circular economy analysis, a new framework for improving corporate sustainability has been proposed.

***Index Terms*— Circular Economy (CE); Sustainable Supply Chin (SSC); Supply Chain (SC); Corporate Sustainability (CS)**

I. INTRODUCTION

Supply chain management was shown to be the most effective corporate strategies for addressing social, environmental, and economic sustainability in recent research on sustainability management [1,2]. Through the cohesive cooperation of all the players of SSCM, the resources of materials, data and finances may be effectively managed to result is optimum output [3]. Over the past 25 years, there have been significant advancements in both the practice and research of sustainable SCM [4]. This has led to the creation of reliable and efficacious information about the nature and implications of various SCM models and techniques [58]. But in recent years, the "circular economy" notion has begun to change how "sustainable supply chain management" is conceptualised [9]. The CE concept suggests connections between the four economic factors that the environment affects in terms of business sustainability: providing value, being a resource, being an economic activity, and being a life-support system [10]. The CE was described as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops with the help of durable design, upkeep, repair, reuse, remanufacturing, refurbishing, and recycling" by Geissdoerfer and colleagues in 2017[11].

The adoption of a CE approach suggests that SSCM should pay more attention to supply chain reversal loops and product transformation [11]. With a goal to eliminate waste and pollution, promote material reuse, and promote ecological resource redevelopment through the CE concept, Industry 4.0 technologies have been investigated as the enablers for sustainable operations and SSCM [12-14). Adoption of cutting-edge technologies for supply chain reconfiguration, such as additive manufacturing, big data, artificial intelligence, and block-chain, improves flexibility in meeting demand and makes planning, forecasting, and optimization easier [15-17]. As a result, we contend that the combined application of these sustainability ideas offers the opportunity to scale up business involvement for sustainability [7.9.14].

It's true that the conceptual reinterpretation of SSCM through a CE perspective has sparked the creation of fresh scholarship. The connections between SSCM and the CE have been studied in two published reviews of the literature to date 17.18]. However, the integrative analyses concentrated on identifying important characteristics that have an impact on SCM in a CE context and were based on somewhat small document collections (80). The current study was created to build on previous studies for the analysis of SSCM within the framework of a circular economy to provide the conceptual and practical value.

Following are the research questions that served as the review's compass.

1. What insights into the development of knowledge on SSCM in a CE may be gained from the dissemination of documents across time, places, and topic areas?
2. What are the important themes, conceptual threads, and cross-disciplinary collaborations in the literature on SSCM in a CE revealed by the most often cited documents?
3. What is the intellectual framework of the body of published knowledge on CE- friendly SCM?

The review looked at 709 Scopus-indexed papers on CE-friendly SCM. These analyses were created to first catalogue the literature and then to examine its conceptual or intellectual frame work. With a focus on the COVID-19 era, this review aims to advance both theory and practice in SCM in a CE. The review is organised into sections that cover the theoretical underpinnings of SCM and the CE, the research methodologies employed, the results connected to the research questions, the interpretation of the findings, and the conclusions.

II. THEORETICAL BACKGROUND

Over the recent three decades, supply chain has emerged as an important management discipline within the greater literature on sustainable management [1-3]. Stakeholder groups (such as government regulators, environmental and social movements, concerned citizens, and consumers) exert pressure and offer incentives on the consumption and production activities of businesses and societies [3, 4]. This is where SSCM comes in. "the management of material, information, and financial flows as well as cooperation among enterprises all along supply chain while drawing objectives from across all aspects of sustainable development, i.e. economic, environmental, and social," as described by Seuring and Müller (2008). (p. 1700).

Governments, financial institutions, corporations, and other sectors must all take action to modify the current system in order to meet the urgent demand for sustainable production and sustainable consumption [19]. The European Circular Economy Action Plan, People's Republic of China's Circular Economy Promotion Law and India's renewable energy policy are examples of how policymakers have recently given the CE concept a higher emphasis [20, 21]. Additionally, since 2017 researchers from a variety of fields have become more interested in the collaborative use of SCM and the CE [22].

The United Nations' 2015 adoption of the 2030 Agenda for Sustainable Development, which features 17 Sustainable Development Goals (UN SDGs) as its centerpiece, has been a major factor in the exponential rise of SSCM publications [3,5,6,23]. SSCM and CE initiatives like recycling have been identified from a business perspective as important measures for attaining corporate sustainability [24-28]. Creating standards controlling relationships between service providers and suppliers in the supply chain can help businesses improve a broad range of environmental and social challenges, including carbon pollution, flood control, waste disposal and minimization, developing skills, and workplace safety [29-33]. Responsible consumption can also be encouraged through the use of CE techniques [34-36], which can be implemented with the use of reverse logistics.

There has been an increase in the sustainability viewpoint in SCM, which has required the implementation of numerous environmental management ideas [37]. In this overview, we compare and contrast four related approaches to SCM that have emerged in the last fifteen years: green, sustainable, closed loop, and circular SCM (see Table 1). Each of these SCM frameworks has its own quirks when viewed through the lens of a circular economy. For instance, in green SCM, the forward and the reverse supply chains are coordinated with one another [38]. Critical to both closed-loop and circular SCM is the creation of value and its maximization through product recovery and waste reduction [39,40]. SSCM, in contrast to alternative frameworks, expressly embraces stakeholder theory [3]. The only SCM methods that aim to affect all three components of both the triple bottom line are the sustainable and circular ones.

Nimsai et al. [23] found an exponential increase in SSCM papers starting about 2010 in their review of the literature from 2020. However, when the evaluation by Nimsai et al. (2020) was completed, the COVID-19 pandemic had not yet begun [41.42), necessitating a reevaluation of management strategies both during and after the pandemic. The global pandemic could be seen as a watershed moment in the evolution of corporate sustainability policies. This demonstrates the value of examining shifts in sustainable supply strategies and the importance of finding novel approaches to current management practices throughout this period of global economic turmoil. In their literature assessment, Türkeli and colleagues [43] found that the concept of a CE was related to ideas such industrial ecology [44], green and bio-economies [45], and sustainability [11]. Reverse supply chains, which focus on recovering products after they have been used. bridge the gap between the CE and SCM [9,46,47]. At the end of a product's useful life, its original manufacturers or other parties may carry out value recovery again for reasons of reuse, refurbishment, and recycling. This article's literature review is organized around the convergence of SCM and the concept of the CE.

Table 1: Four aspects of SCM

Aspects	Definition
Green Supply Chain Management	"Integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end of life management of the product after its useful life" [38].
Sustainable Supply Chain Management	"The management of material, information and capital flows as well as cooperation among companies along the supply chain while integrating goals from all three dimensions of sustainable development. i.e.. economic, environmental and social, which are derived from customer and stake holder requirements"[3].
Closed-Loop Supply Chain Management	"The design, control, and operation of a system to maximize value creation over the entire lifecycle of a product with dynamic recovery of value from different types and volumes of returns overtime" [40].
Circular Supply Chain Management	"The coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/services. by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organizations [39].

Although research into the link between SSCM with economic sustainability has progressed, there has been far less attention paid to the topic in regards to environmental and social sustainability. Enhancing environmental and social sustainability efficiency could be a competitive advantage in the pursuit of economic performance. Intra and inter organizational SC is

formed and regulated by economic systems, social systems, and environmental resources. Achievements in social sustainability, which encompass economic and environmental targets, have received a lot of attention in the literature. There is a shortage of study on working circumstances from such an internal perspective, and other social aspects such as legislative changes or technological challenges can produce friction as if the uneven distribution of advantages were obvious.

On the other hand, the external elements of social SSCM have also been increasing as a result of environmental resource constraints and the expanding population issue in the world. Production and logistical activities use up available resources, add to waste, and raise pollution. The social network between SC partners serves as asset protection against coercive behaviour and adversity, and it aids businesses in preventing unexpected disruptions. Under the alignment contingency, the relational aspect of trust and social capital is thought to stimulate the sharing and trading of external resources obtained from social relationships to aid the company in recovering from shock faster if there were unforeseen catastrophes or interruptions.

Unfortunately, there hasn't been a lot of conclusive study into what factors aid in the growth of social instructive capacities during disaster survival and recovery. How to avoid conflict management and build uniformity among partners by emphasizing trust and shared collaboration mechanisms is an area that has not yet been thoroughly studied. The research has not made clear the significance of knowledge production features like tactical information flow and big data among SC dynamic capabilities and SSCM performance, despite speculation that large social networks may offer information benefits beneficial to ambidexterity. Using social sustainability to manage the difficult and uncertain circumstances is largely uncharted territory. Implementing strategies to reduce pollution has positive effects on efficiency, productivity, and profitability. More money saved by a business thanks to its commitment to environmental sustainability means a more innovative business. In particular, it is suggested that efficient green and product development links to a number of strategies in order to lessen the SC's negative environmental impacts even while trying to address the triple-bottom line objectives. There is an effort here to reduce environmental impacts alongside the enhancement of long-term financial benefits. However, there are no procedures or rules in place to prevent the waste of resources like energy and water that not only impacts the environment and also alters the climate, leaving SCs exposed and under stress.

As a method for quickly adapting to market changes, think about a green SC design and optimization process that incorporates various products, supplier and buyer selection, quality control policies, and a system to manage consign inventory agreements. In addition, comparatively few studies have explored how firms recover from disruptions following the implementation of structural initiatives such as applying technology and human lean concepts. Thus, le innovation strategies come from the merger of purportedly pollution-reduction and performance-enhancement methodologies for green industrial processes. Collaboration on environmental improvement requires further process integration, eco-friendly natural resources, eco-product design. plus customer-based actions.

III. RESEARCH MATHODOLOGY

Scopus is selected as the documentation source [48.51] because it provides more comprehensive coverage of the social management and science literature. For this reason, the researchers focused primarily on articles published in peer-reviewed journals. The conceptual focus of the review is “sustainable supply-chain management in a circular economy," with no attention paid to publication date, industry, or location. A thorough Scopus search using the phrases "supply chain" and "circular economy" in paper titles, abstracts, and keywords was initiated in October 2022. Scopus yielded a preliminary document set consisting of 982 papers from 2006 and October 2022. Scopus filters only allowed articles and reviews from English-language journals, thus 245 of those were disqualified. The writers later sifted through additional items and removed any that were judged to be redundant or irrelevant. Following the selection process, the database of reviews contained 709 scholarly publications.

IV. DISCUSSION

The By clearly tying the related but conceptually different ideas of SSCM and CE together, this research on SSCM in a CE expands on earlier assessments. The review's primary contribution is to provide light on the ways in which the conception of SSCM is enhanced by integration with the CE. This review reaffirmed the emerging nature of the subject of study of SSCM in a CE. Additionally, we think interest in this interdisciplinary area of research, policy, and practice will continue to grow as a result of stakeholder pressure to achieve the UN SDGs (19.102-104].This view is confirmed by the literature's current growth trend and the scholars from the European Union, the United Kingdom, and China who have made policy- driven contributions to this field (57.58]. In fact, the literature already demonstrates remarkably effective collaboration among academics from various geographical regions

An examination of the most commonly cited works in the field highlights the manner by which the CE notion has altered SSCM practices. This change is made possible by the six reversible phases of the circular economy: repair and upkeep. reusing and redistributing, refurbishment and reprocessing, recycle, cascade and recycling, and resource extraction [46. 60]. These sources also demonstrate the potential benefits of reconsidering SCM through the lens of the CE.

Governments should expect to make more progress toward sustainable development targets related to resources safety, emissions reductions, and landfill utilization if supply chain management adopts circular economy concepts [46]. Microeconomic benefits from supply chain collaboration and environmentally friendly operations include increased community support, lessened resource depletion and price fluctuations [13.22.64.66], reduced harmful emissions [19,105], and decreased resource use and price volatility (13.22.64.66). By working together. firms may achieve the critical mass needed to turn a profit from SSCM. Implementing CE principles can put businesses in a better position to compete in global marketplaces, build their brands, find new revenue streams, and mitigate the risks associated with inventory and supply shortages [118, 46, 60, 621].

When SCM incorporates CE ideas, governments can anticipate making greater headway toward sustainable development goals relating to resource security, carbon reduction, and landfill usage [46]. At the micro level, supply chain collaboration and green operations can improve community support while reducing resource scarcity and price volatility [13, 22, 64, 661], lowering harmful emissions [9,105], and reducing resource use and volatility [13, 22, 64, 66]. Collaboration makes it possible to reach the operational critical mass that makes SSCM profitable for certain businesses. Comanies can position themselves to compete in

international markets, establish their brands, generate new sources of income, and lower business risks brought on by inventory and supply shortages by adopting CE principles [18, 46, 60, 62].

The most widely referenced studies also highlight the promise that Industry 4.0 technologies provide for applying the ideas of the CE to SCM. Blockchain, artificial intelligence, big data, and cloud computing are some examples of technologies that can be utilized to improve resource recovery, limit the exploitation of virgin materials, and minimize carbon emissions [12-14]. With the use of these technologies, businesses can more accurately estimate supply and demand, secure sustainable resource use through circularity, and generate new revenue streams from cutting-edge goods and services resulting from CE initiatives. Therefore, the transition from a linear to a CE as well as the development of sustainable consumption and production has the potential to be accelerated by SSCM supported by cutting-edge technologies [106,107].

A change in the way performance measures is used may be necessary to support the business models, strategies, and practices associated with managing supply chains in a CE. according to the analysis of the widely cited documents. More specifically, due to the nature of the CE, each player involved in this multi-level, systemic process will require performance evaluation measures. Environmental, social, and governance (ESG) goals that organizations create, and report reflect pertinent measures at the micro level. However, more focus has to be placed on the macro-level articulation of relation to the UN SDGs as well as the meso-level aggregation of corporate data in the form of industry indexes and benchmarks.

According to the author co-citation map, there are four distinct lines of thought that make up the overall framework of the literature on SSCM in a circular economy. The SCM school of thought conceptualizes SCM with a focus on sustainable development [13, 70]. The centrality of this institution as the conceptual pivot of this literature is highlighted by its inclusion on the map. The second school, dubbed the CE, has focused on a cyclical conception of sustainable production and consumption by way of reimagining procedures, redesigning products, and building new business models [9, 11, 81]. The third school of thought is called Sustainable Production and Environmental Management, and it focuses on how businesses and governments may adjust their methods of operation and production to boost the economy while reducing their negative impact on the environment [87-89]. The last school, Reverse SCM [17, 68, 108], focuses on the role "reverse loops play in a CE and how they contribute to a better knowledge of SSCM.

The map reconceived SCM [47, 99, 100, 109] by connecting corporate practices to production and consumption. According to Nascimento et al. (2019) (14), circular supply networks were crucial for environmentally friendly manufacturing. From production to final consumption, Winkler (2011) [63] emphasized the importance of a coordinated implementation of CE strategies. SSCM is the connecting thread between the three concepts of the CE, sustainable operations, and sustainable consumption, as seen in the map.

CE and sustainable strategies and output are the subject of many research projects in the production sector. It is conceivable to create self-sufficient manufacturing systems that use as little virgin resources as possible through recovering, recycling, and transforming garbage [22, 90, 93]. Recovery of trash that can be repurposed into raw resources for use in newly produced materials, products, and supply networks is the goal of SCM practices in a CE [94, 110]. Extraction, repurposing, or cascading techniques, all of which are fueled by renewable energy, make these systems conceivable [9.11,46]. Researchers have also uncovered CE-related supply chain solutions that promote ethical purchasing practices. Infrastructure that allows servicing and repair, redistribution or reuse, remanufacturing and refurbishment, or recycling services [68, 96, 99, 100, 108]. Education to change customer attitudes and behaviours. Rewards in the form of actual competitive pricing. Infrastructure that encourages self-sustaining production systems, as well as infrastructure that increases consumer responsibility, participation, and awareness, are two examples of what could be done to move more toward sustainable consumption patterns.

Over the past 30 years, research on SSCM has tended to focus on each direction of the chain separately [3-5]. But, as Ludeke-Freund et al. (2019) [60] emphasized, the reverse loop supply chain the backbone of the circular economy's implementation. All of the 45 circular economy methods supplied by Kalmykova et al. (2018) [46, 34] CE practices acknowledged by Govindan and Hasanagic (2018) [7], and 26 corporate models documented by Lüdeke- Freund et al. (2019) utilize the reverse loops of the supply chain. Adopting a CE viewpoint emphasizes the long-term design & reduction strategy that incorporates upstream interaction with suppliers and the forward flow providers.

V. CONCLUSION

The advantages of considering SCM as well as the CE are highlighted by the interactions here between four schools of thought covered in this study. Practitioners and experts in sustainable manufacturing, operations, or supply chain management has increasingly incorporated environmental principles of management during the past 30 years to decrease negative environmental effects. The core SSCM conceptualizations, however, remained faithful to the take-make-dispose linear economic model. The problems of limited supplies, wasteful consumerism, and discarded valuables are ignored by this paradigm. The concept of a CE requires that production and SCM adopt a "systems view" of environmentally friendly procedures. When managers think in terms of the "circular economy," they begin to consider methods of waste prevention, reuse, recycling, recovery, redesign, and remanufacture. However, potting these feedback loop processes into action requires more aggressive participation and coordination from many different stakeholders. In this part of the research, we discuss the implications of the findings and highlight the caveats of the review.

VI. LIMITATION OF THE RESEARCH

Two restrictions need to be mentioned. First, conceptual reviews are intended to examine knowledge base properties rather than focusing on specific findings from a body of literature, as was previously said. Consequently, even though this review did explore theoretical patterns in this developing literature, it did so mostly based on deductions made from co-citation analyses of conceptual information connected to the Scopus-indexed database of documents. Our findings may serve as a foundation for future evaluations that use more in-depth review techniques to examine findings in greater detail.

Second, the authors decided to eliminate publications written in languages other than English in order to facilitate a deeper examination of certain papers. However, it is important to mention that China, Brazil, and Italy were found to be countries that have been very active in conducting research on this subject. Reviews of the literature written in various languages could be a helpful addition to our own studies.

VII. OUTCOMES OF THE RESEARCH

The first implication of this review is found in the world of ideas. Our research led us to revise the sustainability of supply chains in a CE model proposed by Rebs, Brandenburg, and Seuring (2019) [111]. Triple bottom line benefits, stakeholder involvement, and a closed supply chain were the original plan's three primary tenets.

Our suggested model expand on the work of Rebs et al. (2019) [111] by adding a strategic perspective informed by their review of the research on strategic management for sustainability.

The integrated model considers macro-level environmental pressures and stakeholders (like the global SDG movement, transferring market demands, and institutional policies) that can be seen as factors driving shifts in sustainability practices and policies (like equilibrium, resilience, and sustainable development) forward into sustainable futures. The proposed framework has the potential to evolve into a workable business plan that provides honest guidance for long-term enterprise viability.

In view of the persistent challenges seen in implementing a management of supply chains framework for a CE, we emphasize a wide range of policy implications [7,8,82]. Among the most important things to do is to develop policies for circularity, for enforcement agencies to be fortified and for performance management tools to be made more bust and relevant. Capital investment in eco-innovation for the redesign of products and services, production and supply chains with reverse hops, and the use of cutting-edge technology can be made more affordable through the introduction of top-down efforts in the form of subsidies and tax breaks.

Second, in addition to these measures, a platform is needed to promote collaboration between many players both within and outside supply chains, enhance information sharing, and permit improved benchmarking of progress and results. Changing people's mindsets and habits to favor the use of eco-friendly products requires the implementation of consumer education efforts. Recycling is still the "6Ra" practice with the greatest widespread adoption, as pointed out by Ghisellini and Ulgiati (2020) (82). This highlights the need for, and potential for, a variety of CE techniques within the management of commercial supply chains. This points to the necessity for a reorganization of monetary priorities and the development of an infrastructure to enable waste minimization, reuse, recovery, remanufacturing, and redesign strategies.

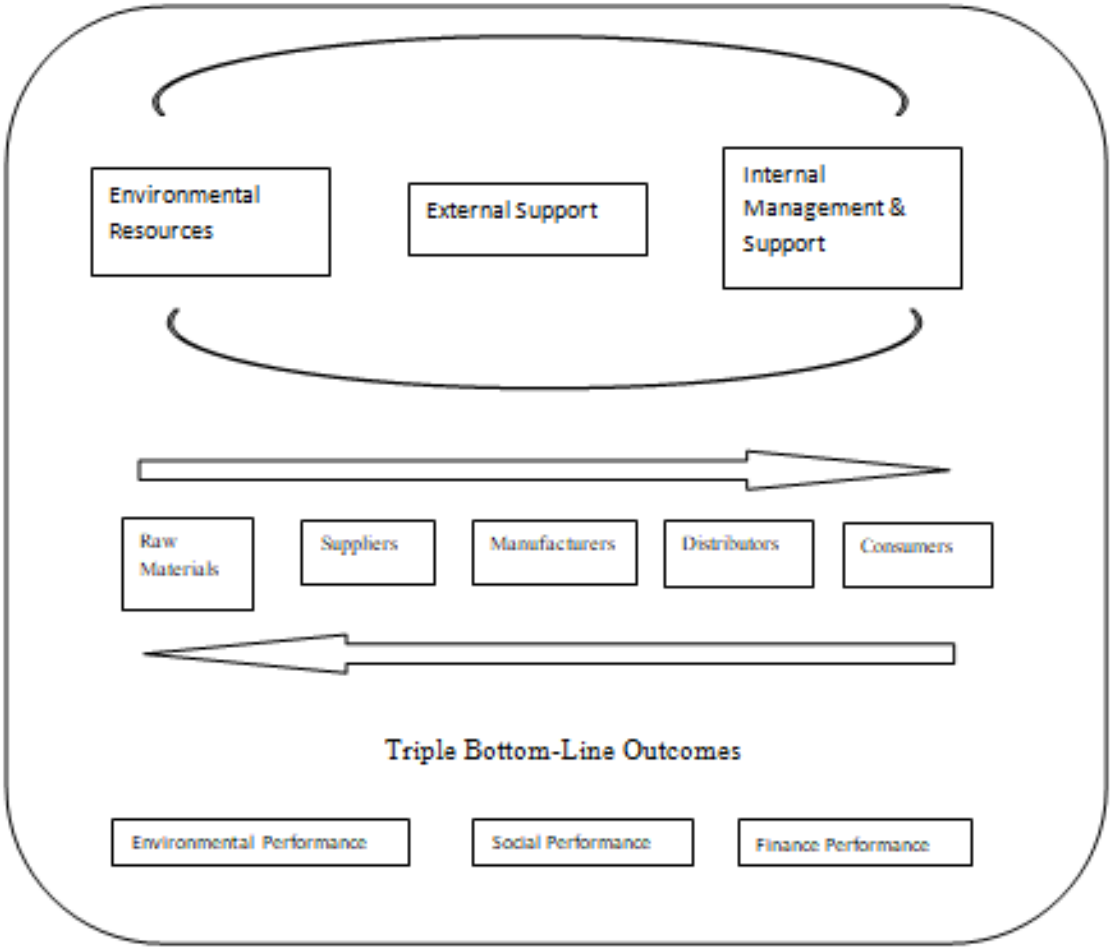
Finally, the proposed framework provides practitioners with analyses of demand and ecological impact, as well as suggestions for the creation of innovative projects. Practitioners, especially in multi-national firms, should seek to strengthen the alignment of ESG goals set at headquarters with ESG actions taken at the local level. The data presented in the review can be used by managers to make a financial case for deploying supply chain reverse loop strategies.

Many promising avenues for future research are suggested by the review's conclusions. First, the proposed framework can be verified and enhanced by further research. Different countries and corporations have different concerns and goals in light of the global spread of the COVID-19 pandemic. There are a number of theories that must be taken into account when validating the environment, including computational complexity and stakeholder theory.

Based on this analysis, it appears that there is a significant lack of research coming from developing countries in the worldwide literature. However, emerging countries play a crucial role in international trade and supply chains. More attention in the future should be paid to how developing nations are using CE concepts to their SCM practices.

Fourth, collaboration among supply chain participants and outsiders has been highlighted as an important factor propelling systemic change [16, 22, 25, 60]. There has to be more research into the roles and responsibilities of pale along the supply chain. The growth agenda, the current level of regulation implementation for the CE, and the global nature of supply chain networks all contribute to the possibility of distinct roles and duties.

The application of performance assessment metrics in SSCM within the framework of the CE is an area that needs further investigation. Examining the relationship between activities and the United Nations Sustainable Development Goals (UN SDG) in the context of environmental, social, and governance (ESG) objectives is one possible area of investigation (UN SDGs). It's important to think about things like company size, location, and organizational structure. In the case of multinational corporations, for instance, performance review and reporting may be centralized at the corporate level, with no regional split, how this would affect individual countries reports of achievement toward the UN SDGs should also be explored.



Model showing three layered Sustainable Supply Chain Management

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