Supply Chain Management and the Circular Economy : A Review of Current Research and Future Trends

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***Abstract*— Supply chain management and the circular economy are not only fascinating areas to study, but also challenging at the moment. The relation between supply chain management and the circular economy is examined in this paper, as well as the future trends of these two areas. The methodology involved content analysis after identifying current relevant research from the Scopus database. A substantial increase in studies on the association of these two areas relates to the implementation of a 3R or 5R approach to supply chain management. Future trends have been identified for three industry sectors: manufacturing, natural resources, and services, all of which are moving in the direction of applying both of these areas to processes in order to reduce resource use, waste, and environmental impact in order to achieve sustainability. The findings will guide these industries in planning and developing these two areas within the organization in order to deal with business changes.**

Keywords—supply chain management, circular supply chain management, circular economy, environmental sustainability, sustainable development

I. INTRODUCTION

Nowadays, firms, as well as governments, place a premium on overcoming economic, social, and environmental challenges. Moreover, the COVID-19 pandemic has exacerbated a growing number of those issues [1]. It is becoming increasingly evident that the economic model that "extract-produce-use-dump" would not be sustainable in the long-term [2]. The circular economy (CE) is the most likely effective solution for achieving sustainability in the future, which deals with resources in terms of "extract-produce-use-return" [3]. The concept of CE as an alternative economic framework has acquired substantial momentum in recent years and is now viewed as a set of guidelines for achieving sustainability at the global, national, local levels [4]. CE concept is grounded on product reuse, remanufacturing, and recycling. It consumes fewer resources and energy, thus being more economical [5]. The increased interest in CE reflects the fact that a diverse variety of entities, including governments, cities, and huge multinational firms, are actively exploring strategies to transition to one [6]. Schroeder et al. [4] concluded that "CE practices could be used as a toolkit and particular implementation methodologies to accomplish several Sustainable Development Goals", emphasizing the critical role that CE reforms will play in achieving these Sustainable Development Goals. Apart from pursuing sustainability, numerous operators employ supply chain management (SCM) in a variety of methods by incorporating the Sustainable Development Goals [7]. SCM is focused on producing value to ensure that the company retains competitive advantage. To this end, the adoption of ideas like sustainable supply chain management (SSCM) and green supply chain management (GSCM) has been implemented [8]. From each concerns, including economic, social and environmental, SSCM and GSCM are adopted as an effective management solution for reducing product's and its life cycle's environmental impact, hence achieving sustainability in all aspects of the firm's operations [9].

There have been a host of studies on SCM and CE. This paper describes the definitions of SCM and CE, as well as the link between the two areas, based on an examination of the relevant literature. Additionally, it gives context for current research and trends for the future in the industry regarding SCM and CE is provided.

This paper is divided into five main sections, commencing with this one. The theoretical background is covered in next section. The third part is an explanation of the methodology. And afterward, the research findings are provided. Finally, the conclusion is presented, with industry adaptation guidelines as uncovered through the literature review along with future proposals for future research.

II. THEORETICAL BACKGROUND

A. Supply chain management

In 1982, Keith Oliver introduced the concept of SCM. It attracted the attention of academia and industry and has been used for a long time [10-11]. It has been defined as the administration of relations among suppliers and customers in order that provide more value to customers at a lower cost throughout the supply chain from upstream to downstream [12]. Additionally, it has been defined as the management of a system of relations between and within an organization's and units of business's that enables the forward as well as the backward flow of materials, information, finances, and services from manufacturers to consumers, with the advantage of enhancing value, increasing earnings via increased efficiency, and satisfying the customers [11].

B. Circular economy

CE is a system in which no material is wasted, being founded on three principles: eliminating waste and pollution, recirculating resources and products within the system, and protecting and improving the environment [5, 13-14]. The concept is being used to address environmental sustainability issues. Furthermore, CE model emphasizes waste reduction and resource optimization [15], along with the repurposing of end-of-life materials and waste, all of which help the

2022 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT & NCON) |
978-1-6654-9510-3/22/$31.00 ©2022 IEEE | DOI: 10.1109/ECTIDAMTNCON53731.2022.9720414

environment and economy. However, the term CE encompasses a number of distinct concepts and with its practice being focused on the production and consumption processes inside a single firm at the micro-level. While it is implemented at the meso-level through techniques, such as industrial coexistence and resource sharing [16]. Obviously, macro-level adoption of CE, i.e., national/international/global level would require major policy changes by governments and international bodies [17].

III. Research Methodology

As this research is focused on trends regarding SCM and CE, thehe initial search was conducted using the Scopus database with the keywords "supply chain," "management," and "circular economy." There were 449 items in the initial set of results; however, only scientific publications and full-text articles were selected, thus resulting 240 articles. After that, we identified the content that was appropriate in terms of relating to SCM and CE, resulting in the extraction of 145 articles. Then, content analysis was applied to investigate the current research and industry's future trends.

Identification	Screening	Eligibility	Included
- Scopus database - Keywords: "supply chain" AND "management" AND "circular economy"	- Only scientific publications and full-text papers - Removing duplicates	- Related research to the topic .	- 145 articles included in the content analysis
N = 449	N = 240	N = 145	

Fig. 1. Research Methodology

IV. Results

A. Overview

From 2012 to 2016, only a small number of articles appeared, which was followed by a substantial growth in subsequent years. In 2020, the number of papers published was 47, indicating a strong upward trend in interest in both of these fields, as shown in Figure 2

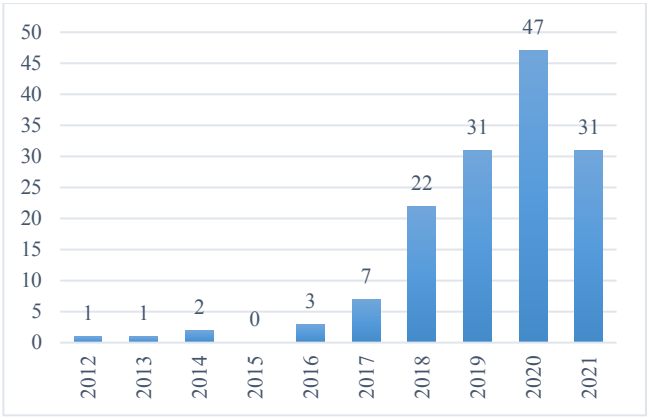

Fig. 2. Number of publications by year

Figure 3 shows that the articles were published under 55 different journal titles, with most being in five main journals. The Journal of Cleaner Production, with 21 articles, had the most related articles and Sustainability was second with 20. These were followed by Resources Conservation and Recycling (19 articles), Business Strategy and the Environment (8 articles), and six articles in Production Planning and Control. It emerged that the main sources with the most articles published were concerned with environmental, cultural, economic, and social sustainability.

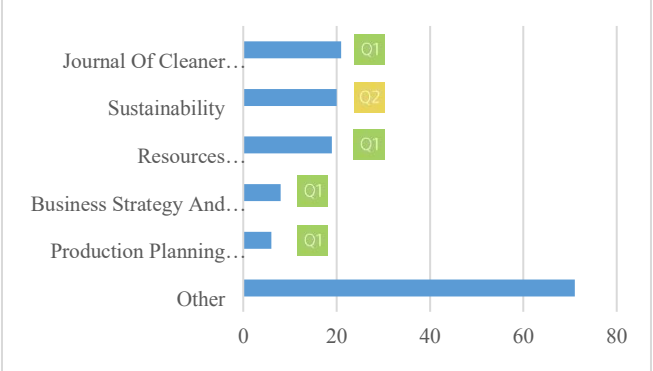

Fig. 3. Distribution of publication by Journal title

The authors were affiliated to institutions in 46 nations across six continents: Europe (20), Asia (17), South America (3), Australia (2), Africa (2), and North America (2). As shown in Figure 4, Most authors were from the United Kingdom, China, Italy, India, and the United States, in descending order.

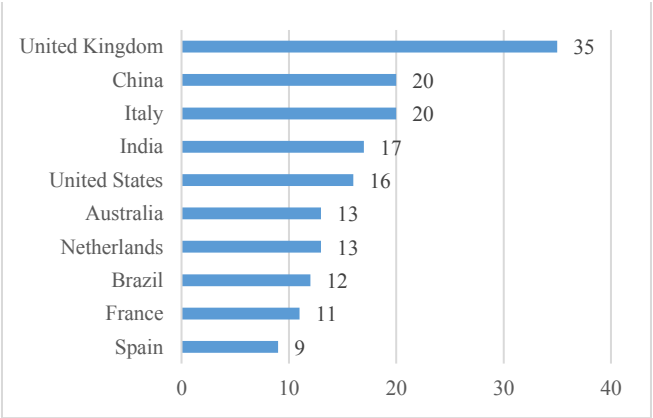

Fig. 4. Distribution of publications by authors' country

Moreover, the findings show the three authors with the most articles published, as can be seen in Figure 5. That is, each with a total of four publications, are: Yigit Kazancoglu (Yasar University), who specializes in SCM, operations management, and sustainability; Joseph Sarkis (Worcester Polytechnic Institute, Business School), who is interested in environmental sustainability, operations, and SCM; and Abraham Zhang (Essex Business School), who specializes in CE and sustainability.

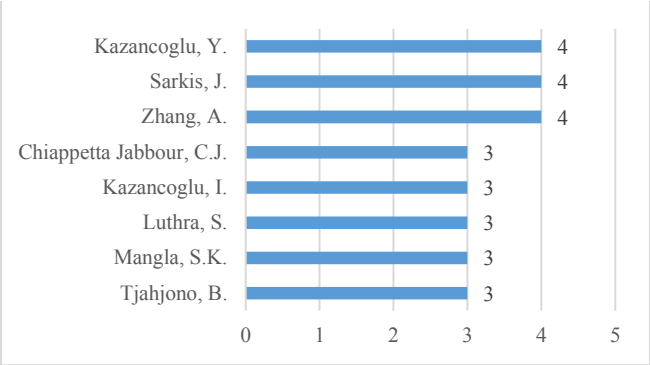

Fig. 5. Distribution of papers by author

In addition, Environmental Science, Business, Management, and Accounting, and Engineering are the three main subject areas, which constitute more than 50% of all the papers, as presented in Figure 6.

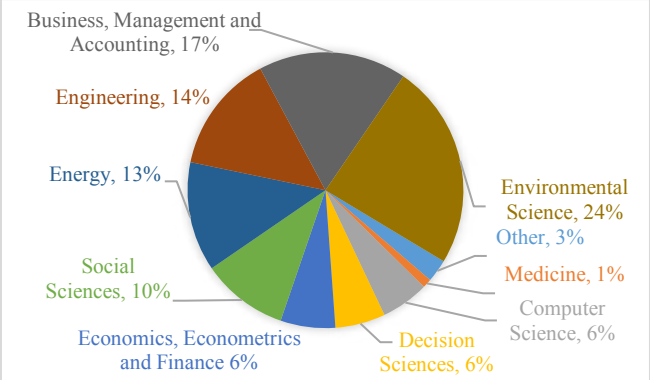

Fig. 6. Distribution of papers by subject area

B. *The relation between supply chain management and the circular economy*

According to reviewed studies, CE has been applied to a variety of SCM applications. The most evident are green supply chain management (GSCM), sustainable supply chain management (SSCM), closed-loop supply chain management (CLSCM), and circular supply chain management (CSCM), which all have distinct concepts and practices [18-21]. The aim of GSCM is to transform the traditional supply chain into GSCM, or activities that are more environmentally friendly. This impacts the supply chain environment. Whilst SSCM pertains to improving long-term company performance by focusing on social and environmental metrics through SCM processes [19], whereas CLSCM is aimed at transforming products that consumers no longer want to reuse, refurbishing, repair, remanufacture, or recycle, thus reducing the environmental impact [20]. Finally, the objective of CSCM is to implement circular concepts into SCM and the adjacent industrial and biological ecosystems. The ultimate aim is to achieve zero waste through innovation in supply chain processes and business models on system-wide [21].

1) Green supply chain management

The concept of GSCM is that is applied to all supply chain operations and thus, is environmentally friendly [22-23]. The objective is to decrease the environmental effect of the product's life cycle, through environmentally friendly design, resource efficiency, reduced material consumption or production of environmentally hazardous products, and ecologically friendly transportation [24]. GSCM provides numerous benefits, including cost savings, profit maximization, increased customer and employee satisfaction, market expansion, reduced environmental impact through waste reduction, hazardous material reduction, the use of recycled or renewable materials, and reduced material consumption [25-26]. By incorporating a CE into GSCM, the 3 Rs principle of Reuse, Reduce, and Recycle is applied to each cycle of the supply chain [27].

2) Sustainable supply chain management

SSCM perspective is concerned with incorporating environmental issues within the organization through the reduction of material loads or the mitigation of unexpected negative consequences of production and consumption processes and is mainly focused on reusing and remanufacturing [28-29]. Thus, SSCM is coordinating the activities of the operation of an organization's fundamental business units and each business transfers its social duty to its partners through collaboration aimed at meeting the needs of customers and stakeholders. There are three pillars of sustainable development that must be taken into consideration, namely the economy, social, and environmental dimensions [30-31]. Sustainable design and relationship management about the supply chain are critical elements of SSCM practice that can indicate an organization's circular economy capability. To this end, it is critical for businesses to integrate and allocate resources in order to enhance their total environmental performance [32-34].

3) Closed-loop supply chain management

CLSCM is described as the process that designing, controlling, and operating systems in order to optimize value throughout a product's life cycle over time by dynamically recovering value from rates of return and various types [20]. Closed-loop supply chain (CLSC) expands upon existing reverse logistics models by incorporating remanufacturing, reuse, repair, refurbishing, and recycling (5Rs) in accordance with CE guidelines [35]. Hence, familiarity with CE enhances the possibility of transferring to a CLSC [36].

4) Circular supply chain management

The combination of a SCM and CE is referred to as CSCM [37]. The application of supply chain circulation depends on increasing the product's life or the amount of remanufacturing, repairs, refurbishing, and recycling cycles, as well as extending the time material can be used [38] in order to deliver a more environmentally friendly manufacturing process. Additionally, it is more efficient and thus, will increase the organization's profitability [39].

C. *Future trends of supply chain management and circular economy in industry*

SCM and CE are being applied in many industry sectors. In particular, the evidence indicates that there are three sectors, including manufacturing, natural resources, and services pursuing this arrangement.

Regarding the manufacturing sector, firms in the agro-food industry as well those making various consumer products and industrial ones have reported pursuing zero waste in their supply chain and resource conservation through remanufacturing. Many manufacturers have been seeking to eliminate production waste, by converting defective or low-quality products or using end-of-life product parts, to make new products [40-42]. Refurbishing and recycling methods have become popular in this sector in addition to remanufacturing [43-44]. Due to the changes in manufacturing industry, with the automation trend towards Industry 4.0, there are many manufacturers that have implemented technology that emphasizes the use of 3D printing technology, big data, and Internet of Things to increase automation productivity, enhance the efficiency of communication and system monitoring as well as to enable machines to analyze and solve problems themselves without human intervention [45-48].

In the natural resources sector, it has been determined that e-waste mining from discarded electrical and electronic equipment or urban mining is a more environmentally friendly alternative to traditional mining. This is another form of implementing CLSCM under the concept of 3Rs: Reduction, Reuse and Recycling, which involves careful management of the extraction of rare chemicals and other materials. It is a method of sustainable exploitation of mineral resources, because it eliminates the need for major or rare earth elements found in nature and stimulates the flow of supply chains. It can provide raw materials at lower cost, reduce energy consumption and reduce emissions. Urban mining can also be a better alternative to extracting minerals, and of course, to traditional mining with its uncertainties [49-51].

Additionally, there is the service sector. The content review revealed a strong emphasis on transport and logistics, with a focus on reducing transport-related pollution. This is because land transportation is a major contributor to environmental problems, climate change and air pollution. The transition from the CE and functional economy to a reliance on material reduction within the economy will result in a reduction in the environmental effect associated with transportation, such as a reduction in emissions through improved exhaust and engine efficiency [52]. In addition, sea freight operators have also adopted GSCM through operations that include: creating an environmental management system and logistics that are environmentally friendly by optimizing the efficiency of the flow for various transportation modes [53]. In addition to the usage of GSCM, there are applications in which CSCM is being employed, such as in the context of structural changes that are happening in the economy, commerce, and water transportation. The purpose of these activities becomes to increase energy efficiency, reduce carbon emissions, decrease reliance on fossil fuels, optimize waste management, as well as involve stakeholders [54].

V. Conclusion

This research purpose was to investigate current research and to analyze future trends in the industry with regard to SCM and CE to provide the industry sectors interested in these two areas with knowledge that could be developed and implemented appropriately in the future. It has been shown that CE is linked to SCM from four different perspectives: GSCM, SSCM, CLSCM, and CSCM. Hence, it is recommended that manufacturing, natural resources, and service industries should adopt the integration of SCM and CE in relation to future operations, thus achieving sustainability. Future research should focus on specific industries, rather than just manufacturing, natural resources, and services in general, thereby identifying what practices can be most beneficial.

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