# Sheffield Hallam University

# Analyzing the drivers of smart sustainable circular supply chain for sustainable development goals through stakeholder theory

KAYIKCI, Yasanur <http://orcid.org/0000-0003-2406-3164>, KAZANCOGLU, Yigit, GOZACAN CHASE, Nazlican and LAFCI, Cisem

RESEARCH ARTICLE

Business Strategy
and the Environment
WILEY

# Analyzing the drivers of smart sustainable circular supply chain for sustainable development goals through stakeholder theory

Yasanur Kayikci[1,2] 🔵    |    Yigit Kazancoglu[3] 🔵    |    Nazlican Gozacan-Chase[3]    |    Cisem Lafci[3]

[1]Department of Engineering and Mathematics, Sheffield Hallam University, Sheffield, UK

[2]Science Policy Research Unit, University of Sussex Business School, Brighton, UK

[3]International Logistics Management Department, Yasar University, Izmir, Turkey

**Correspondence**
Dr Yasanur Kayikci, Department of Engineering and Mathematics, Sheffield Hallam University, Sheffield, UK.
Email: y.kayikci@shu.ac.uk; yasanur.kayikci@gmail.com; yk327@sussex.ac.uk

## Abstract

The concept of sustainable development is becoming incomprehensible and complex in global supply networks, especially in low- and middle-income countries (LMIC) that are most affected by ever-changing industry challenges and standards. Smart technologies emerged by Industry 4.0, sustainability, and circular economy (CE) connection, which remain unexplored, can be integrated into the supply chain as a business strategy to increase collaboration and cooperation between different tiers of the supply chain to achieve sustainable development goals (SDGs) according to LMIC. Therefore, the main objective of this paper is to discover the drivers of a smart sustainable circular supply chain (SSCSC) in achieving the SDGs in LMIC through stakeholder theory. First, a systematic review is employed to identify the drivers of the SSCSC to achieve the SDGs in the LMIC incorporating existing literature on the subject. Second, the Best-Worst Method (BWM) is applied to analyze the identified drivers, and then the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is used to analyze the SDGs. The applicability of the solution methodology was illustrated by providing a numerical example. The results of the study are twofold: firstly, drivers are analyzed by implementation of BWM. The results of the BWM reveal that economic sustainability is the best key driver among the eight driversin achieving the SDGs, meaning that without financial assistance and support achieving the SDGs becomes ineffective. Secondly, the TOPSIS analysis reveals that SDG 16 (peace, justice, and strong institutions) is the SDG most supported by drivers.

**KEYWORDS**
circular economy, industry 4.0, low- and middle-income countries, resource efficiency, smart sustainable circular supply chain, stakeholder theory, sustainability, sustainable development goals

## 1 | INTRODUCTION

As in a linear economy, the standard process of supply chains utilizes the raw materials for the industrial manufacturing process (Goyal et al., 2018) and turns them into waste after consumption. However, the linear economy model is incapable of managing the supply and demand balance in the utilization of natural resources (Rajput & Singh, 2019). In addition to that, innovative manufacturing methods, models, and services as a business strategy aimed at protecting natural resources and the environment have led to increased awareness of climate change and ecosystem deterioration worldwide (Bassetti et al., 2021; Dwyer et al., 2009; Linnenluecke et al., 2012). Therefore,

the source of circular economy (CE) is attributed to supply chains to provide environmentally effective strategies and business responses (Okorie et al., 2018). In this sense, it presents a better alternative to the linear economy, which is widely adopted today (Werning & Spinler, 2020), in terms of environmental management. CE is an economic model that aims efficient use of resources for waste minimization, long-term value retention, elimination of the primary resources, and closed-loop of products, parts, and materials inside of the field of environmental protection, and socio-economic benefits (Morseletto, 2020) and efficient resource, energy, and water use restricting waste that circulates into the atmosphere (Liu et al., 2018). From a broader perspective, a detailed definition of CE is provided by Kirchherr et al. (2017, p. 224) as follows:

> "A CE describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro-level (products, companies, consumers), meso-level (eco-industrial parks) and macro-level (city, region, nation and beyond), to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."

In the light of this definition, the objective of CE is to add value to the materials and products, to achieve maximum length of the life cycle, and to renew them until their end-of-life (Kouhizadeh et al., 2020). As the supply chain is influenced by this attribution of CE with the increasing cost, complexity, uncertainty, and vulnerability; the managers seek cheaper, faster, and better vertical and horizontal supply chain collaboration.

Developing alternatives to integrate sustainable supply chain collaboration with CE principles has then become necessary (Genovese et al., 2017). Also, the considerable increase in sustainability is being considered as an active response by companies to increased requests and pressure on corporate sustainability for sustainable development by stakeholders (Burritt & Schaltegger, 2010; Dong et al., 2014; Laguir et al., 2019; Qian et al., 2020). Thus, sustainable circular supply chain (SCSC) is generated as an environmental strategy by combining the concepts of sustainability and CE and presents a novel approach and compelling viewpoint to the field in a consideration of forward and reverse supply chain (Guide et al., 2003; Guide & Van Wassenhove, 2009; Kayikci et al., 2021; Murthy & Evans, 2016). It is a restorative and regenerative cycle that is designed relying on circular thinking, and it aims at a zero-waste economy because of CE philosophy (Farooque et al., 2019). The SCSC focuses on the closed-loop system by reversing the product by an external recycler to close the material gap between the company and the consumer (Murthy & Evans, 2016). Thus, CE principles such as reuse, repair, remanufacturing, and recycling are enabled through the SCSC collaboration to sustain value circulation consistently (Batista et al., 2018) by integrating the range of potential CE and supply chain combinations (Masi et al., 2017). Furthermore, economic and business opportunities are also significant

drivers for the transition toward SCSC, as well as resource scarcity, global resources concerns, and environmental issues (Jain et al., 2018).

Supply chains are also required to be smarter to overcome the aforementioned challenges (Butner, 2010; Wu et al., 2016) and also to provide sustainable output (Zouari et al., 2021) and reduce human–machine interaction for easier adoption of sustainability practices to facilitate CE principles (Yadav et al., 2020). For this purpose, Industry 4.0 (I4.0) technologies bring the "smart concept" and generate smart SSCSC to be flexible and versatile, rendering them responsive (Butner, 2010; Gupta et al., 2019; Kayikci et al., 2021) with transparency and sustainable collaboration (Duan et al., 2021) as seen in Figure 1. SSCSC consists of multi-tiers and multiple stakeholders within a vertical and horizontal collaboration. Thus, the processes within the supply chain need the assistance of information technologies. In that sense, supply chains promise an ideal playground for the convergence of sustainability, CE, and I4.0 technologies.

SSCSC performs better not just traditional financial performance indicators but also social and environmental indicators. These indicators help measure performance in ensuring long-term sustainability by considering key factors (Gozacan & Lafci, 2020). As part of the 2030 Agenda, sustainable development goals (SDGs) were formed in 2015 as a "blueprint to achieve a better and more sustainable future for all" consisting of 17 interlinked global goals (UN, 2016). The SDGs are designed for the implementation of mechanisms to bring various actors together to actively align their efforts with a common goal (Fowler & Biekart, 2017). This idea critiques economic growth as the only bottom line and it underlines the necessity of balancing economic, ecological, and social development in moving toward a sustainable economy and society (Qian et al., 2020). SDGs mostly address low- and middle-income countries (LMIC). For this reason, the implementation of SDGs in LMIC with the vertical and horizontal collaboration SSCSC proposes is of great importance. From this point of view, CE principles may be utilized as a toolbox to achieve a wide variety of SDGs (Schroeder et al., 2019) as a part of SSCSC. Most importantly these smart circular activities are required to reach the collaboration of multi-tier supply chains (Fabbe-Costes et al., 2011). To the best of our knowledge, sustainability, CE, and I4.0 dimensions have not been extensively studied together until now due to the recent emergence of the interaction between them. In addition, the interaction between supply chain, sustainability, CE, and I4.0 has not been examined in the literature. Also, considering SDGs, the vertical and horizontal effects of these three dimensions on collaboration in LMICs have never been studied in the literature. All these aspects reveal a research gap. To close this research gap, more comprehensive management models and strategies that recognize the complexity of sustainable development and promote collaborative action and partnerships are required to prevent negative effects and optimize positive benefits across all social sectors, public, private, and civil society sectors (van Zanten & van Tulder, 2021; van Tulder & Keen, 2018). Based on this research gap, the objective of this study is to investigate the drivers within the concept of SSCSC to achieve the SDGs in LMIC through stakeholder theory. Therefore, the main contribution of this study is to provide an SDG guideline for LMIC by integrating the sustainability, circularity and smartness perspectives into the supply chain within the concept
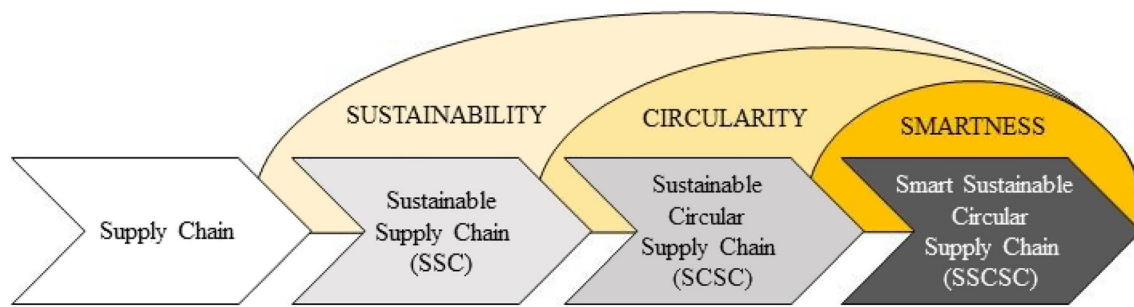
**FIGURE 1** Evolution of smart sustainable circular supply chain [Colour figure can be viewed at wileyonlinelibrary.com]

of SSCSC, as effective implementation of SDGs is a great challenge for LMIC. In this sense, this paper aims to fill this gap by providing both proactive and reactive solutions and contributions to this issue. The novel approach is accomplished by applying a Systematic Literature Review (SLR) to identify drivers, followed by the Best-Worst Method (BWM) for the analysis of these drivers, and then the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for the analysis of SDGs. This paper contributes to the literature by proposing a roadmap for the practitioners and academicians by presenting drivers and analysing the interrelationships between them in terms of the implementations of SSCSC for SDGs in LMIC. Research questions (RQs) are generated stepwise in line with the motivations mentioned to accomplish the analysis of the overall objective of the research. RQs are shown clearly in Table 1.

The organization of the paper, seen in Figure 2, is as follows: collaboration for sustainable development with the lens of stakeholder theory is explained and the drivers of the SSCSC are identified by conducting an extensive SLR in Section 2. In Section 3, solution methodology is given to analyze the relationships between drivers using BWM and SDGs using TOPSIS method. In Section 4, a numerical example is given to demonstrate the results. Section 5 includes a discussion on findings. Section 6 presents the implications of this study. Finally, Section 7 concludes the paper with the limitations and future direction of research.

## 2 | COLLABORATION FOR SUSTAINABLE DEVELOPMENT: STAKEHOLDER THEORY

Supply chain management is critical in adopting sustainable manufacturing and improving the performance of the organization (Kumar et al., 2020; Shi et al., 2017; Wu et al., 2016). Integrating the concept of sustainability with key business activities related to supply chain management, such as procurement, logistics, and knowledge management, has resulted in a vital and multidisciplinary subject known as sustainable supply chain management (Morali & Searcy, 2013). Because of the rising complexity of global supply networks, sustainable development is gaining traction (Li & Mathiyazhagan, 2018) among organizations, multinational corporations, and various tiers of supply chains to achieve sustainable development. However, sustainable development adoption necessitates collaboration across all levels of the business, from multinational

**TABLE 1** Research questions and motivations

| # | Research question | Motivation |
|---|---|---|
| RQ1 | What are the addressed drivers of SSCSC for SDGs in LMIC? | Exploring the potential of SSCSC for achieving SDGs through identifying the drivers. |
| RQ2 | What are the interrelationships to these drivers? | Analyzing the integration of the sustainability, circularity, and smartness perspectives in supply chain for SDGs in LMIC. |

corporations to small and medium enterprises (Li & Mathiyazhagan, 2018) since sustainable supply chain management is an action that contributes to the achievement of sustainable development (Diabat et al., 2014).

SDGs were established in 2015 as part of the 2030 Agenda, including 17 interconnected global goals to balance social, economic, and environmental sustainability (UN, 2016). Middle-income countries are significant partners in the implementation of the 2030 Agenda and have much to share from their efforts to achieve the SDGs, including with the low-income countries (UN, 2018). To ensure that the development is sustained and sustainable, it is needed to improve the international competitiveness and access to newer technologies which is the main challenge since it is the limited capacity to absorb and develop technologies, given their infrastructural and institutional bottlenecks (UN, 2018). A key objective of the agenda is also to highlight the focused and enhanced support, including improved coordination that the United Nations development system, the international financial institutions, regional organizations, and other stakeholders can extend to middle-income countries (UN, 2018) and low-income countries.

The fact that sustainability management and stakeholder theory both contain a long-term point-of-view is justified by their strategic planning similarities (Hörisch et al., 2014; Figge et al., 2002; Freeman, 1994). The stakeholder theory becomes one of the most powerful and widely utilized theoretical tools for value creation (Tapaninaho & Heikkinen, 2022) by numerous academics, and it resulted in significant progress in dimensioning sustainability (Khosravi & Izbirak, 2019; Barić, 2017; Alves & Rodrigues, 2019; Carroll & Brown, 2018; Clark et al., 2015) since the objective of stakeholder theory is to establish mutual benefit for all stakeholders
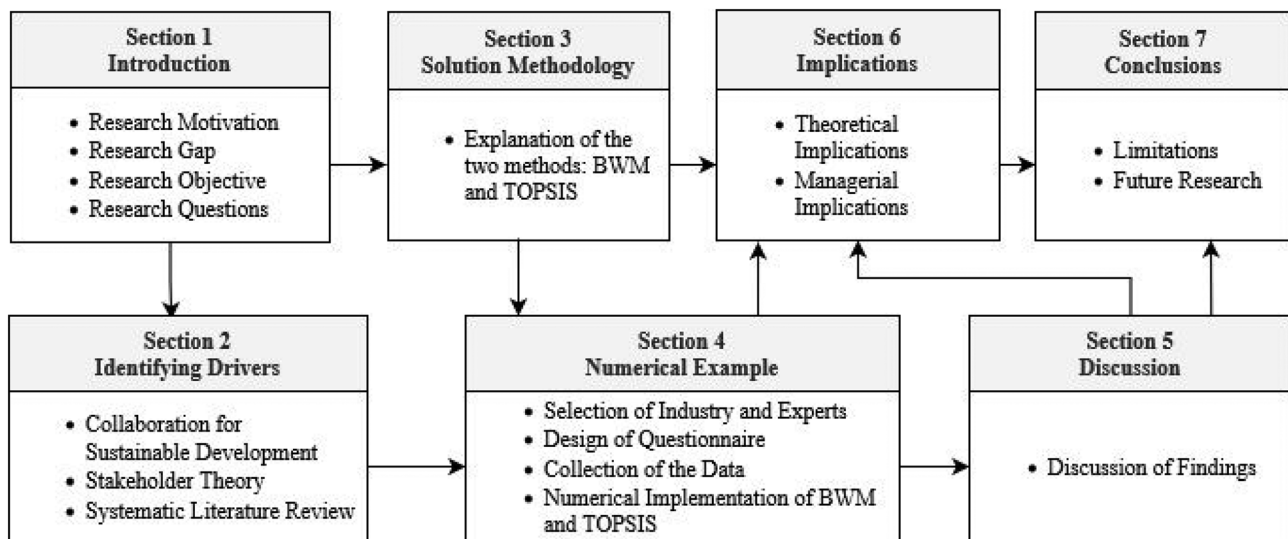
**FIGURE 2**  Organization of the paper

(Freeman, 1994) as in the 2030 Agenda. This wide concept of value is explicitly embraced by stakeholder theory, which deliberately extends further defining value in a mere money perspective (Hörisch et al., 2014). According to Hörisch et al. (2014), the necessity to establish innovative approaches in the framework of sustainability management that improves the quality of life (Gladwin et al., 1995) corresponds to stakeholder theory, which is more engaged with quality of life than simply monetary goals (Freeman et al., 1994). Therefore, the stakeholder theory is being considered as the most formidable framework for measuring sustainability and the vast majority of scholars agree that social sustainability and stakeholder theory are compatible (Bellantuono et al., 2016; Collier et al., 2014; Herazo & Lizarralde, 2016; Khosravi & Izbirak, 2019; Perrini & Tencati, 2006). Because of the high involvement of various tiers of the supply chain, their cooperation and collaboration are needed (Savage et al., 2010) for achieving SDGs in LMIC. Collaborative or proactive strategies toward sustainability incorporate sustainable development throughout basic company concepts as well as seek to interact productively with confrontational or disengaged stakeholders, demoralized staff, inefficient activities, including reduced market share (Perey et al., 2018). Stakeholder theory suggests that companies that want to conduct successful business must consider the opinions and expectations of their stakeholders (Freeman, 1994). Therefore, high involvement, long-term commitment, and collaboration of various tiers of the supply chain are needed for supply chains to achieve SDGs in LMIC. Supply chains offer collaborative platforms for addressing responsibility by internalizing environmental and social externalities (Carter & Jennings, 2002; Chien & Shih, 2007; Morali & Searcy, 2013; Roberts, 2003; Sarkis et al., 2010). In such a competitive environment, which is composed of various stakeholders, each organization and stakeholder must respond to the pressure and take appropriate action (Meherishi et al., 2019) collaboratively. To manage and maintain these collaborations in supply chain networks, the stakeholder theory has a lot to offer to supply chains. Because it is critical to understand each stakeholder's role and how it may be expanded to allow the shift from a linear to a CE

(Meherishi et al., 2019) in supply chains and accomplish SDGs in LMIC. Therefore, investigating these collaborative interactions, particularly social partnerships, calls into question parts of both descriptive and instrumental stakeholder theory (Savage et al., 2010).

Sustainable development in LMIC and other countries requires a collaborative system that starts recycling the materials used in manufacturing processes and adds these materials to the smart closed-loop system as in SSCSC. For this reason, the implementation of SDGs in LMIC with the vertical and horizontal collaboration SSCSC proposes is of great importance as stakeholder theory suggests. In this context, circular practices are recognized as a means to advance toward sustainable development, resource efficiency, and a low-carbon economy (Wright et al., 2019) as a part of SSCSC since the reason underneath for expediting and driving the willingness to embrace circular principles arisen from the need to decrease negative unsustainable environmental consequences that occurred due to the existing linear supply chains such as resource scarcity, waste disposal, destruction of natural resources, and energy consumption. Thus, as a toolkit for achieving a broad variety of SDG goals, CE principles can be utilized (Kayikci et al., 2021; Schroeder et al., 2019). Within SSCSC, the circular principles are supported by the relationship between I4.0 and sustainability. Therefore, manufacturing industries cannot disregard the influence of I4.0 on supply chains and sustainability necessity (Fallahpour et al., 2017; Liao et al., 2017; Luthra et al., 2020; Quezada et al., 2017; Thornton, 2017) because I4.0 technologies are hastening manufacturing digitalization and correspondingly reshaping the whole value chain (Merkel et al., 2017; Queiroz et al., 2020). I4.0 can be defined as an integration of digitization into business operations and procedures for intelligence and has a wide range of applications in many fields (Lin et al., 2017; Luthra et al., 2020). However, implementation of I4.0 technologies is currently in its early stages, particularly in developing countries (Luthra & Mangla, 2018) as LMIC and it is important to highlight that the adoption of I4.0 in the manufacturing industry is simpler in developed economies than in developing economies (Fettermann et al., 2018; Luthra et al., 2020).

## 2.1 | Systematic literature review

There is a substantial number of papers in the current literature investigating prominent SCM issues such as sustainability, CE, I4.0, and SDGs. However, a holistic approach that combines these concepts in a theoretical and practical manner is missing in literature and requires immediate attention. Since the main purpose of this paper is to present, identify, and analyze the key drivers of SSCSC to achieve SDGs in LMIC, search strings were established for the searching process in Web of Science (WoS) as seen in Figure 3. The search string of SLR is as follows:

| Search dimensions | Search strings. TITLE-ABS-KEY { |
|---|---|
| Supply chain | ("supply chain" OR "green supply chain" OR "sustainable supply chain" OR "green manufacturing" OR "sustainable manufacturing") AND |
| Sustainability | ("sustainable development goals" OR "SDG" OR "sustainability" OR "sustainable" OR "sustainable development" OR "environmental sustainability" OR "social sustainability" OR "economic sustainability" OR "triple bottom line" OR "corporate sustainability") AND |
| Circularity | ("circular economy" OR "green economy" OR "circularity" OR "reuse" OR "reduce" OR "recycle" OR "repair" OR "remanufacture" OR "repurpose" OR "recycle" OR "recover" OR "rethink" OR "9R") AND |
| Smartness | ("industry 4.0" OR "I4.0" OR "manufacturing 4.0" OR "digital*" OR "internet" OR "big data" OR "Blockchain" OR "internet of things" OR "IoT" OR "sensors" OR "machine learning" OR "cyber-physical systems" OR "artificial intelligence" OR "AI" OR "cognitive computing" OR "virtual reality" OR "augmented reality" OR "VR/AR" OR "3D printing" OR "4D printing" OR "additive manufacturing" OR "cloud computing" OR "edge computing" OR "mobile devices" OR "5G" OR "robotics" OR "unmanned aerial vehicle" OR "UAV" OR "nanotechnology" OR "self-driving vehicles" OR "automated guided vehicles" OR "AGV" OR "radio frequency identification" OR "RFID" OR "near field communication" OR "NFC" OR "M2M") AND |
| LMIC | ("LMIC" OR "low and middle-income countries" OR "low-income countries" OR "middle-income countries") AND |
| Drivers | ("drivers" OR "success factors")}. Limit to: Doctype (article and review) |

After a well-established systematic review and examination of the current literature, the most appropriate publications were determined to be used in this study. As a result of an extensive examination of the literature background, 100 publications were found. To ensure the quality of the paper content, the search was limited to articles and review papers, thus, conference papers, books, book chapters, and reports were excluded from the search. Seventy-three publications in total were agreed on to be examined to find the drivers of the SSCSC in LMIC. The most frequently adopted drivers were found and collected by examining these publications. After the collection of the related drivers, a group of experts who are comprised of a broad interdisciplinary audience were gathered to discuss these drivers for validity. At the end of the group discussion, the SSCSC's drivers for achieving the SDGs in the LMIC were identified from the available literature.

As a result of the SLR, Figure 4 shows the yearly distribution and the number of publications. Year 2018 is the year that has the highest number of publications on the SSCSC concept with 17. This declined to 15 in 2019 and 13 in 2020. Figure 5 displays the yearly distribution of the publication in terms of journals. The top five most preferred journals were classified as follows: *Journal of Cleaner Production* (21), *Resources, Conservation and Recycling* (5), *Production Planning and Control* (5), and *Sustainability* (4).

## 2.2 | Drivers of the smart sustainable circular supply chain

In this part of the article, the available literature is reviewed to find the addressed drivers of SSCSC for SDGs in LMIC. As a result, the literature on drivers for achieving SDGs in LMICs has been evaluated and compiled in Table 2 to answer RQ1. The explanations of the drivers were also presented in the table for further understanding of the drivers and their interactions with the paper.

## 3 | SOLUTION METHODOLOGY

In this study, BWM and TOPSIS methods were used as a solution methodology. BWM is a comparative multi-criteria decision-making method (MCDM) that compares the best criterion to all other criteria before comparing all other criteria to the worst criterion (Zhao et al., 2018). The objective of this technique is to use a basic optimization model to discover the best weights and consistency ratio (Zhao et al., 2018). The approach was chosen because it offers numerous benefits over other MCDM methods, such as analyzing small group pairwise comparisons in this method rather than the entire pairwise comparison matrix in other MCDM methods (Agrawal & Vinodh, 2021). Additionally, utilizing expert opinions is a beneficial strategy in the presence of uncertainty generated by technological innovations since experts have a stronger comprehensive understanding of cause-effect relationships. BWM is easy and precise because the implementation of secondary comparisons is not necessary (Haseli et al., 2021; Ghoushchi et al., 2019; Rezaei, 2015a). Also, TOPSIS is utilized to analyze SDGs since TOPSIS aims to identify the best alternative that is both the closest to the positive ideal solution and the most far away from the negative ideal solution (Karim & Karmaker, 2016). TOPSIS has several benefits, including its ease, rationality, and comprehensibility, as well as its high processing performance and potential to quantify the relative performance per each alternative in a simple mathematical format (Roszkowska, 2011).
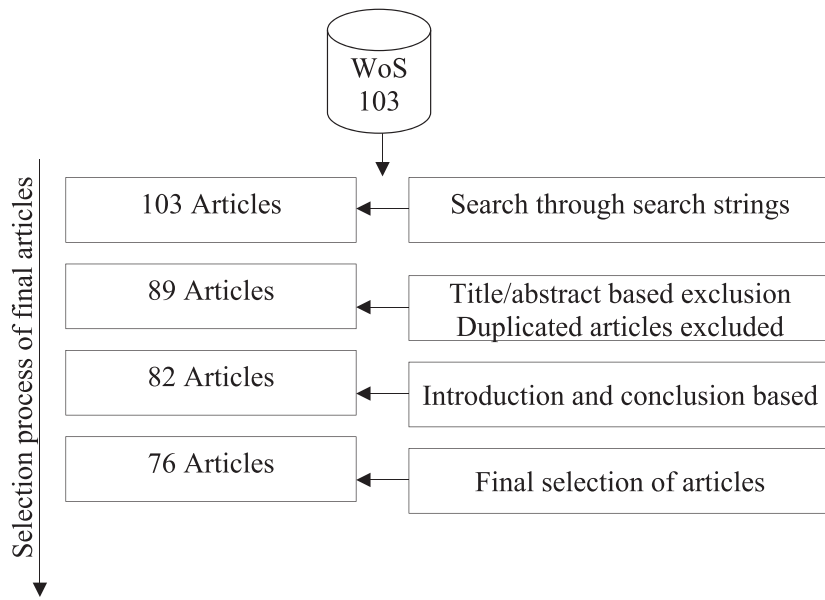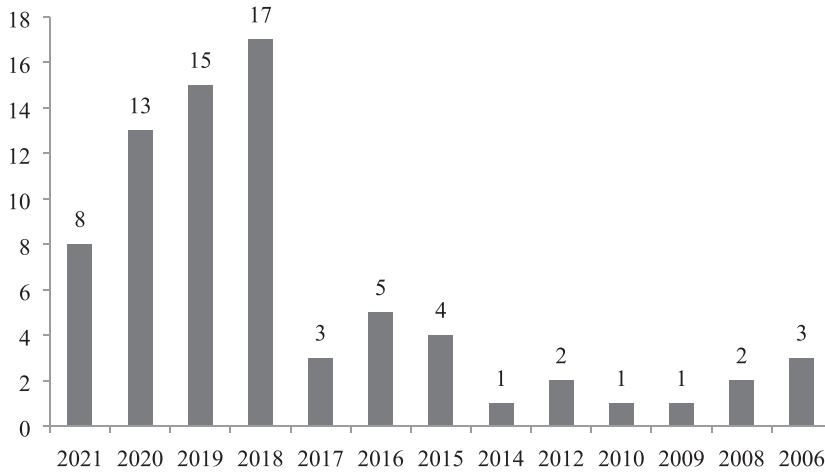
FIGURE 3    Data collection process

Selection process of final articles

WoS 103

103 Articles ← Search through search strings

89 Articles ← Title/abstract based exclusion
Duplicated articles excluded

82 Articles ← Introduction and conclusion based

76 Articles ← Final selection of articles

FIGURE 4    Yearly distributions of the publications

| Year | Count |
| --- | --- |
| 2021 | 8 |
| 2020 | 13 |
| 2019 | 15 |
| 2018 | 17 |
| 2017 | 3 |
| 2016 | 5 |
| 2015 | 4 |
| 2014 | 1 |
| 2012 | 2 |
| 2010 | 1 |
| 2009 | 1 |
| 2008 | 2 |
| 2006 | 3 |

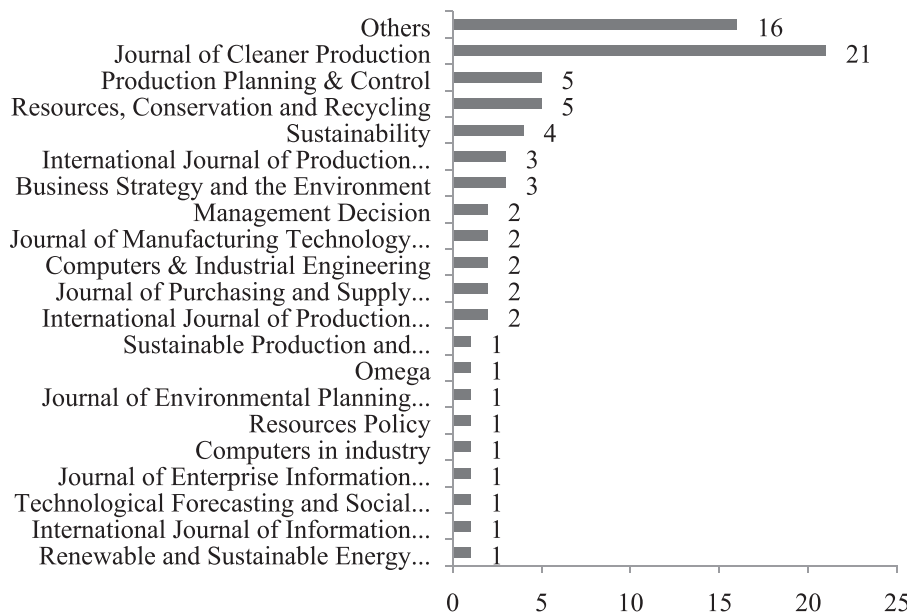| Journal | Count |
| --- | --- |
| Others | 16 |
| Journal of Cleaner Production | 21 |
| Production Planning & Control | 5 |
| Resources, Conservation and Recycling | 5 |
| Sustainability | 4 |
| International Journal of Production... | 3 |
| Business Strategy and the Environment | 3 |
| Management Decision | 2 |
| Journal of Manufacturing Technology... | 2 |
| Computers & Industrial Engineering | 2 |
| Journal of Purchasing and Supply... | 2 |
| International Journal of Production... | 2 |
| Sustainable Production and... | 1 |
| Omega | 1 |
| Journal of Environmental Planning... | 1 |
| Resources Policy | 1 |
| Computers in industry | 1 |
| Journal of Enterprise Information... | 1 |
| Technological Forecasting and Social... | 1 |
| International Journal of Information... | 1 |
| Renewable and Sustainable Energy... | 1 |

FIGURE 5    Distribution of the journals

**TABLE 2** Drivers of the Smart sustainable circular supply chain

| Drivers | | Explanation | References |
|---|---|---|---|
| D1 | Economic sustainability | Potential to increase sustainable, committed, and strong employment in circular practices by providing employees financial assistance. This driver also includes the concentration of environmental costs, such as expenses associated with the current or future deterioration of natural resources due to economic activity of smartness and circular supply chain ecosystem vertically and horizontally. | Dantas et al. (2021); Chen et al. (2020); Elia et al. (2020); Fatimah et al. (2020); Tura et al. (2019); Diabat et al. (2014); Gabzdylova et al. (2009); Carter and Rogers (2008) |
| D2 | Policy and regulations | Effective and supportive government regulations and policies on cyber security and circular activities are necessary to eliminate threats and weaknesses while planning smart circular operations of the supply chain ecosystem vertically and horizontally following the existing regulations. In addition, pricing, taxes, and financial subsidies are beneficial strategies for guiding people's consumption behaviors in the direction of sustainable circularity. | Nasir et al. (2021); Chen et al. (2020); Tura et al. (2019); Bag et al. (2018); Bonilla et al. (2018); Luthra and Mangla (2018); Dong et al. (2016); Hermann et al. (2016); Ilić and Nikolić (2016); Witjes and Lozano (2016); Bai et al. (2015); Kagermann (2015); Velis and Vrancken (2015); Diabat et al. (2014); Yu et al. (2014); Stahel (2013); Faisal (2010); Brown (2009); Gabzdylova et al. (2009); Marshall et al. (2005); Zhu et al. (2005); Desrochers (2001) |
| D3 | Supply chain connectivity | Considering organizational policy in implementing I4.0 technologies and escalating supply chain sustainability entails international cooperation and collaboration among vertical and horizontal members of the supply chain ecosystem while increasing the satisfaction of the environmentally sensitive consumer with circular and sustainable products and processes with the boost of smartness. | Badraoui et al. (2021); Nasir et al. (2021); Elia et al. (2020); Tura et al. (2019); Luthra and Mangla (2018); Müller et al. (2018); Pfohl et al. (2017); Reddy et al. (2016); Turker (2015); Diabat et al. (2014); Hussain (2011); Faisal (2010); Lee (2008); Cox et al. (2007); Jamison and Murdoch (2004); Geffen and Rothenberg (2000); Innes & Booher (2000); Brandenburger and Nalebuff (1996) |
| D4 | Social sustainability | Reducing harmful substances or using non-chemical circular materials and processes with proper standards for sustainable health and safety for employees. Also, a smart circular sustainable supply chain ecosystem reduces the consumption of hazardous materials in the vertical and horizontal supply chain operations to provide a pollution-free environment while increasing globalization and global awareness of the need for sustainability. | Fatimah et al. (2020); Tura et al. (2019); Luthra and Mangla (2018); Murray et al. (2017); Wolf (2017); Diabat et al. (2014); Waheed et al. (2009); Carter and Rogers (2008); Carter et al. (2007) |
| D5 | Organizational competency | Detection, identification, and management of supply chain risks, diverse emissions, and their origin activities can be discovered due to the integrated sustainability, circularity in the harmonized supply chain ecosystem, and advanced cooperation and collaboration via transparency that is driven by smart technologies. Moreover, high support, commitment, and involvement of top management provide innovation, infrastructure to improve circular practices and increase their performance. This driver also prioritizes organizational learning, smart circularity for the sustainable welfare of people, and is ethical and supportive vertically and horizontally. | Nasir et al. (2021); Elia et al. (2020); Bag et al. (2018); Luthra and Mangla (2018); Müller et al. (2018); Pfohl et al. (2017); Savtschenko et al. (2017); Wan et al. (2016); Faisal (2010); Swee et al. (2010); Carter and Rogers (2008); Klimley (2005); Rice (2003); Roberts (2003); Zsidisin and Siferd (2001); Zsidisin and Hendrick (1998); Walton et al. (1998) |

(Continues)

**TABLE 2** (Continued)

| Drivers | | Explanation | References |
|---|---|---|---|
| D6 | Human resources competency | Increasing workforce knowledge, training, and expertise in the supply chain ecosystem by providing appropriate technology, and public awareness of circularity education and sustainability concepts drive thoughts to act responsibly to environmental issues vertically and horizontally. | Liboni et al. (2019); Lopes de Sousa Jabbour et al. (2018); Fettermann et al. (2018); Luthra and Mangla (2018); Lin et al. (2017); Schuster et al. (2016); Faisal (2010); Brown (2009); Geldermann et al. (2007); McKeown et al. (2002); Wright (2002) |
| D7 | Information technology competency | A fully equipped facility with the adoption of emerging technologies IT-based technologies and infrastructure provides the required network, connectivity, sustainable compatibility, and traceability of the information across the vertical and horizontal circular and sustainable supply chain ecosystem. | Nasir et al. (2021); Tseng et al. (2021); Chen et al. (2020); Elia et al. (2020); Tura et al. (2019); Lopes de Sousa Jabbour et al. (2018); Luthra and Mangla (2018); Ghisellini et al. (2016); Lacy and Rutqvist (2015); Ellen MacArthur Foundation (2013); Hofmann et al. (2012); Mathews and Tan (2011); Zhijun and Nailing (2007) |
| D8 | Environmental sustainability and circularity | Environmental responsibility for environmental sustainability is an immense concern to consumers. Thus, products and services of circular eco-design are designed via smart operations with the minimum amount of detrimental environmental effect as a result of cooperation in the supply chain ecosystem vertically and horizontally. | Dantas et al. (2021); Nasir et al. (2021); Fatimah et al. (2020); Tura et al. (2019); Ghisellini et al. (2016); Andrews (2015); Lacy and Rutqvist (2015); Linder and Williander (2017); Murray et al. (2017); Diabat et al. (2014); EC (2014); Moreno et al. (2014); Ellen MacArthur Foundation (2013); Kok et al. (2013); Hofmann et al. (2012); Vojdani and Lootz (2012); Gabzdylova et al. (2009); Bhaskaran et al. (2006) |

## 3.1 | Best-Worst Method

In MCDM methods, the process starts with $n$ criteria and it is intended to perform a pairwise comparison on a scale of 1/9 to 9 as seen below,

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \qquad (1)$$

where $a_{ij}$ indicates the relative preference of criterion $i$ to criterion $j$. Here, $a_{ij} = 1$ indicates that $i$ and $j$ are of identical significance. $a_{ij} > 1$ indicates that $i$ is more significant than $j$. If $a_{ij} = 9$, there is an extreme significance of criterion $i$ to criterion $j$. Similarly, the significance of $j$ to $i$ is indicated by $a_{ji}$. $a_{ji}$ is required to be equal to $1/a_{ij}$ so it can be reciprocal (Rezaei, 2015a). BWM consists of two parts, which are reference pairwise comparisons and secondary pairwise comparisons (Rezaei, 2015b). In this way, the necessary number of pairwise comparisons can decrease to $2n - 3$ which includes pairwise comparisons of best criteria to other criteria $(n - 2)$, pairwise comparisons of other criteria to the worst criterion $(n - 2)$ and pairwise comparisons of the best criterion to the worst criterion $(+1)$ (Guo & Zhao, 2017). Rezaei (2015a, 2015b) explains BWM as follows,

*Step 1. Identify the decision-makers and the decision-making criteria:* $\{C_1, C_2, ..., C_m\}$ is considered as a set of criteria and $\{DM_1, DM_2, ..., DM_n\}$ is considered as a set of decision-makers.

*Step 2. Decide which criteria are the most important (best) and which are the least significant (worst):* Every decision-maker chooses the best and worst criteria overall.

*Step 3. Use the scale of 1 to 9 (see Table 3) to perform pairwise comparisons of the best criterion with other criteria:*

$$A_{Bj} = (a_{B1}, a_{B2}, ..., a_{Bm}) \ (j = 1, 2, 3, ..., m) \qquad (2)$$

where $a_{Bj}$ denotes the relative importance value of the best criterion over criterion $j$.

*Step 4. Use the scale of 1 to 9 to perform pairwise comparisons of the worst criterion with other criteria:*

$$A_{jW} = (a_{1W}, a_{2W}, ..., a_{mW}) \ (j = 1, 2, 3, ..., m) \qquad (3)$$

where $a_{jW}$ denotes the relative importance value of criterion $j$ over the worst criterion.

*Step 5. Calculate the optimum criterion weights $(w_1, w_2, ..., w_n)$ for each group:* $a_{Bj} = w_B/w_j$ and $a_{jW} = w_j/w_W$. The calculated weights are non-negative.

$$minimize \max_j \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_W} - a_{jW} \right|$$
$$subject\ to \begin{cases} \sum_{j=1}^{n} (w_j) = 1 \\ w_j \geq 0\ for\ all\ j \end{cases} \qquad (4)$$

**TABLE 3** 1/9 to 9 (Rezaei, 2015a)

| Equal importance | Somewhat between equal and moderate | Moderately more important | Somewhat between moderate and strong | Strongly more important | Somewhat between strong and very strong | Very strongly important | Somewhat between very strong and absolute | Absolutely important |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Now, Equation 4 can be written as below and optimal criteria weights for each group and the value of $\xi$, can be calculated.

$$\text{minimize } \xi$$
$$\text{subject to} \begin{cases} \left| \dfrac{w_B}{w_j} - a_{Bj} \right| \leq \xi, \\ \left| \dfrac{w_j}{w_W} - a_{jW} \right| \leq \xi, \\ \sum_{j=1}^{n}(w_j) = 1 \\ w_j \geq 0 \text{ for all } j. \end{cases} \quad (5)$$

Step 6. Final weights of each group are calculated using the average weights:

$$w_j = \frac{\sum_{k=.}^{n}(w_{jk} \times n_k)}{N} \forall j, \quad (6)$$

where $n_k$ denotes the number of decision-makers in the $k$th group and $N$ indicates the total number of decision-makers where $N = (n_1, n_2, ..., n_n)$.

The consistency ratio which is indicator for the consistent degree of comparisons is calculated using $\xi$ and the consistency index value (Haseli et al., 2021) as below,

$$\text{Consistency ratio} = \frac{\xi}{\text{Consistency index}} \quad (7)$$

Furthermore, Table 4 indicates the consistency index.

Rezaei (2015a) states that inconsistency occurs when $a_{Bj} = a_{jw} \neq a_{Bw}$. Also, this means $a_{Bj} \times a_{jw}$ can be less or more than $a_{Bw}$. Maximum consistency is obtained as $a_{Bj}$ and $a_{jw}$ have the greatest value (same with $a_{Bw}$), which is conducted to $= 0$. In addition,

$$(a_{Bj} - \xi) \times (a_{jw} - \xi) = (a_{Bw} + \xi) \quad (8)$$

For maximum consistency,

$$(a_{Bw} - \xi) \times (a_{Bw} - \xi) = (a_{Bw} + \xi) \quad (9)$$

Equation 9 can be also written as

$$\xi^2 - (1 + 2a_{Bw})\xi \times (a_{Bw}^2 - a_{Bw}) = 0 \quad (10)$$

## 3.2 | TOPSIS

TOPSIS is a multi-criteria decision analysis method, which was primitively proposed by Hwang and Yoon (1981), which explains the steps as follows:

*Step 1: Decision makers rate values for the alternative with respect to criteria on a decision matrix considering* Table 3: According to arithmetic mean of pairwise comparisons from decision group, a comparison matrix A is constructed (see Equation 1).

*Step 2: Normalize decision matrix:*

$$\overline{X}_{ij} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{n} X_{ij}^2}} \quad (11)$$

where $\underline{X}_{ij}$ is the normalized score and $X_{ij}$ is the original score.

*Step 3: Construct the weighted normalized matrix:*

$$v_{ij} = w_i \times \underline{X}_{ij}, \ j = 1, 2, 3, ..., J, \ i = 1, 2, 3, ..., n \quad (12)$$

where $w_i$ represents weights.

*Step 4: Determine the positive ideal solution (PIS) and negative ideal solution (NIS):*

$$A^* = \{v_1^*, v_2^*, ..., v_n^*\} \text{ maximum values (13)}$$
$$\text{Where } v_i^* = \{max(v_{ij})\} \text{ if } j \in J; (v_{ij}) \text{ if } j \in J^-$$
$$A^- = \{v_1^-, v_2^-, ..., v_n^-\} \text{ minimum values (14)}$$
$$\text{Where } v_i^- = \{min(v_{ij})\} \text{ if } j \in J; (v_{ij}) \text{ if } j \in J^-$$

*Step 5: Calculate the distance of each alternative from PIS and NIS:*

$$d_i^* = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^*\right)^2}, j = 1, 2, ..., J \quad (15)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}, i = 1, 2, ..., J \quad (16)$$

| $a_{BW}$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Consistency index | 0 | 0.44 | 1 | 1.63 | 2.3 | 3 | 3.73 | 4.47 | 5.23 |

**TABLE 4**  Consistency index (Rezaei, 2015a)

*Step 6: Calculate the closeness coefficient (CC$_i$) t to the ideal solution of each alternative*:

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-}, i = 1, 2, ..., J. \qquad (17)$$

*Step 7: Rank the alternatives*: Alternatives are ordered from most valuable to least valuable depending on the descending values of $CC_i$.

# 4 | NUMERICAL EXAMPLE

The textile industry was selected to study SDG access in LMIC by applying a supply chain concept that manages to combine CE, I4.0, and sustainability. The reason underneath of choosing the textile industry for the implementation of this study is because of the direct effect of the textile industry on the SDGs in LMIC because the textile industry has a unique position that includes industries such as agriculture and engaged cross-cutting activities. Hence, these integrated industries are also affected by the attention made to the textile industry. The numeric examples of this study obtained through examining the SSCSC drivers identified in the previous section. Numeric data were obtained and evaluated through a questionnaire by the 16 decision-makers from the textile industry. The average work experience of experts is 16 years in the textile industry. In addition, the educational background of the participants is at least at the undergraduate level. Nine experts have bachelor's degrees, five experts have master's degrees, and two experts have doctorate degrees. The distribution of the experts according to the tiers from downstream to upstream of the textile supply chain is shown in Figure 6. It is important to note that some respondents indicated that they are involved in more than one tier of the textile supply chain. This study was pursued between April 1 and July 31, 2021.

The interaction among the drivers in SC for SDGs in LMIC was analyzed by using BWM and TOPSIS method. Using questionnaire, the 16 participants defined the most and least significant driver, as well as the best and worst criteria. Obtained data from the questionnaire have been used to identify the best and worst drivers to achieve SDGs in LMIC. In this context, Table 5 illustrates the best and worst drivers. Later, using a 1–9 scale, participants were requested to express their choice for the best criterion over all other criteria. With the same measurement scale of 1–9, respondents were also required to assess the preference rate of all criteria over the least important criterion through a questionnaire.

Table 6 represents the final findings of the BWM application. The findings can be utilized to develop strategic management decisions. The maximum criterion weight is 0.130 for D1 (economic sustainability). When it comes to achieving SDGs in LMICs, economic
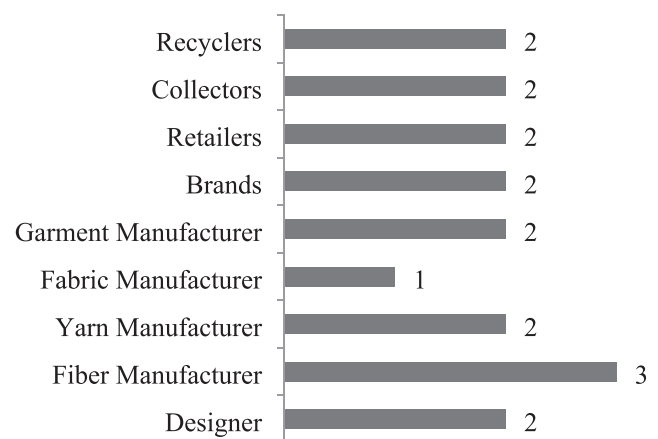
**FIGURE 6**  Tier of the textile supply chain

**TABLE 5**  Best and worst drivers determined by experts 1–16

| Drivers | Best | Worst |
|---|---|---|
| D1 (economic sustainability) | 1, 9, 10, 13, 14 | |
| D2 (policy and regulations) | 5, 8 | 4 |
| D3 (supply chain connectivity) | 2, 6, 11 | |
| D4 (social sustainability) | | 2, 8, 11, 14 |
| D5 (organizational competency) | | 3, 7, 13, 16 |
| D6 (human resources competency) | 4 | 1, 5, 6, 9, 10, 12, 15 |
| D7 (technology potential) | 15 | |
| D8 (environmental sustainability and circularity) | 3, 7, 12, 16 | |

**TABLE 6**  Results of BWM: Driver weights for the 16 respondents

| Drivers | Geometric mean of weights | Standard deviation |
|---|---|---|
| D1 (economic sustainability) | 0.130 | 0.149 |
| D2 (policy and regulations) | 0.097 | 0.098 |
| D3 (supply chain connectivity) | 0.122 | 0.129 |
| D4 (social sustainability) | 0.078 | 0.038 |
| D5 (organizational competency) | 0.065 | 0.030 |
| D6 (human resources competency) | 0.083 | 0.095 |
| D7 (technology potential) | 0.096 | 0.087 |
| D8 (environmental sustainability and circularity) | 0.128 | 0.142 |

sustainability is the most important driver. D8 (environmental sustainability and circularity) and D3 (supply chain connectivity) ranked next, with criteria weights of 0.128 and 0.122, respectively. This conclusion for LMIC suggests that economic sustainability necessitates the highest and most immediate managerial focus to contribute to the achievement of enhanced SDGs overall. Once economic sustainability is established and executed, it will serve as a foundation for the adoption and improvement of the other criteria, ultimately contributing to the advancement of the SDGs as a whole. D5 (organizational competency) is the least important driver, with a weight of 0.065.

As the final step of BWM, the prioritization result of SSCSC drivers for SDGs in LMIC is as seen below:

$$D_1 > D_8 > D_3 > D_2 > D_7 > D_6 > D_4 > D_5$$

After the drivers were analyzed with BWM, the effects of drivers on SDG were examined with TOPSIS. While examining the importance of drivers on SDGs in the survey, participants were first asked the Yes–No question to find out whether drivers are important for SDGs. As a result of this question, all drivers and all SDGs were found important. Afterward, the evaluation was performed using a 1/9–9 scale. The driver weights to be used in the TOPSIS process were obtained from the BWM method. As a result of taking the arithmetic average of the decision-maker evaluations (Karim & Karmaker, 2016), the decision matrix shown in Table 7 was obtained. The normalized matrix calculated in the next step based on this matrix is also seen in Table 8.

Table 9 shows the answer of RQ2 via the ranking based on PIS (Si+) and NIS (Si−). As can be seen in this table, the importance of the identified drivers is greatest on SDG 16 (peace, justice, and strong

institutions) with 0.76. This is followed by SDG 9 (industry, innovation, and infrastructure) with 0.67. SDG 15 (forests, desertification, and biodiversity) is in the third ranking with 0.61. If we look at the last three SDGs, SDG 2 (zero hunger) is ranked last with 0.29. SDG 8 (Decent Work and Economic Growth) was second to last with 0.39. SDG 1 (No Poverty) is seen with 0.42 before SDG 8.

## 5 | DISCUSSION

Inequalities have risen dramatically in many nations, while the environment has been severely damaged on an unprecedented scale (Sachs, 2015). To deal with these inequalities, maintain sustainability, and eliminate detrimental effects on the environment, creating solutions to combine SSCSC became required. SDGs are crucial strategies for maintaining continuous sustainability in the ever-changing market conditions in LMIC and these SDGs have the capabilities to create a solution to these challenges confronted by the supply chains. Therefore, achieving SDGs has great importance for LMIC, and integrating-smart technologies into the supply chain assist the transition from linear to CE more smoothly and swiftly. For that reason, circularity, and smartness (the role of technologies) of the supply chain are vital to achieving the SDGs. In this context, this paper contributes to the literature by depicturing and emphasizing the important points of drivers to focus on to achieve SDGs in LMIC. However, achieving SDGs in LMIC requires additional effort rather than emerging economies. In this context, CE and I4.0 technologies can be considered as a promoter to achieve various SDGs in LMIC.

Given the several similarities among countries, an internationally coordinated effort to create an open knowledge platform containing

**TABLE 7** Decision matrix

| Weights Drivers | 0.163 D1 | 0.121 D2 | 0.153 D3 | 0.098 D4 | 0.081 D5 | 0.104 D6 | 0.120 D7 | 0.160 D8 |
|---|---|---|---|---|---|---|---|---|
| SDG 1 | 9 | 8 | 7 | 6 | 6 | 5 | 8 | 7 |
| SDG 2 | 8 | 8 | 6 | 7 | 5 | 4 | 7 | 7 |
| SDG 3 | 9 | 8 | 6 | 7 | 6 | 5 | 8 | 8 |
| SDG 4 | 8 | 8 | 6 | 7 | 6 | 9 | 8 | 7 |
| SDG 5 | 8 | 8 | 7 | 8 | 7 | 8 | 6 | 5 |
| SDG 6 | 8 | 8 | 6 | 6 | 6 | 6 | 9 | 9 |
| SDG 7 | 9 | 8 | 6 | 7 | 6 | 6 | 9 | 9 |
| SDG 8 | 9 | 8 | 7 | 7 | 6 | 6 | 7 | 6 |
| SDG 9 | 8 | 8 | 8 | 7 | 7 | 7 | 9 | 8 |
| SDG 10 | 9 | 8 | 7 | 8 | 7 | 8 | 7 | 6 |
| SDG 11 | 9 | 8 | 7 | 8 | 6 | 6 | 8 | 9 |
| SDG 12 | 8 | 7 | 6 | 8 | 6 | 6 | 7 | 9 |
| SDG 13 | 8 | 8 | 7 | 8 | 6 | 6 | 8 | 9 |
| SDG 14 | 8 | 8 | 6 | 8 | 6 | 5 | 8 | 9 |
| SDG 15 | 9 | 8 | 7 | 8 | 6 | 6 | 8 | 9 |
| SDG 16 | 9 | 8 | 8 | 7 | 8 | 7 | 9 | 8 |
| SDG 17 | 8 | 8 | 7 | 6 | 6 | 6 | 8 | 7 |

**TABLE 8**  Normalized matrix

| Drivers | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 |
|---|---|---|---|---|---|---|---|---|
| SDG 1 | 0.24980 | 0.25773 | 0.25188 | 0.20983 | 0.23593 | 0.19547 | 0.24146 | 0.21272 |
| SDG 2 | 0.23542 | 0.23100 | 0.20507 | 0.23314 | 0.19741 | 0.16410 | 0.20282 | 0.22625 |
| SDG 3 | 0.24440 | 0.24818 | 0.22959 | 0.25222 | 0.23593 | 0.20271 | 0.23566 | 0.23399 |
| SDG 4 | 0.23901 | 0.25009 | 0.22959 | 0.24586 | 0.24075 | 0.32820 | 0.25498 | 0.21465 |
| SDG 5 | 0.23722 | 0.25582 | 0.24965 | 0.26706 | 0.25278 | 0.31613 | 0.17771 | 0.16244 |
| SDG 6 | 0.23901 | 0.24436 | 0.20507 | 0.20135 | 0.22389 | 0.22202 | 0.26464 | 0.27846 |
| SDG 7 | 0.24620 | 0.23100 | 0.22513 | 0.23526 | 0.22389 | 0.23891 | 0.26464 | 0.27266 |
| SDG 8 | 0.25519 | 0.24627 | 0.23627 | 0.22043 | 0.24797 | 0.24615 | 0.22600 | 0.18758 |
| SDG 9 | 0.23362 | 0.24627 | 0.26748 | 0.22255 | 0.26964 | 0.26304 | 0.27816 | 0.24752 |
| SDG 10 | 0.24800 | 0.24055 | 0.25856 | 0.25434 | 0.26482 | 0.30407 | 0.21441 | 0.17404 |
| SDG 11 | 0.25159 | 0.24246 | 0.24296 | 0.26494 | 0.23352 | 0.21960 | 0.25691 | 0.27460 |
| SDG 12 | 0.23362 | 0.22718 | 0.22959 | 0.25646 | 0.22871 | 0.22202 | 0.22407 | 0.27653 |
| SDG 13 | 0.23542 | 0.25009 | 0.24519 | 0.27553 | 0.23834 | 0.22202 | 0.25305 | 0.27846 |
| SDG 14 | 0.22823 | 0.23291 | 0.22736 | 0.25646 | 0.23112 | 0.20995 | 0.25498 | 0.27653 |
| SDG 15 | 0.24620 | 0.22909 | 0.24296 | 0.26282 | 0.24315 | 0.22926 | 0.25305 | 0.27653 |
| SDG 16 | 0.25878 | 0.25391 | 0.29868 | 0.25222 | 0.29853 | 0.26063 | 0.26464 | 0.25333 |
| SDG 17 | 0.23901 | 0.23291 | 0.26079 | 0.19287 | 0.24075 | 0.21478 | 0.23373 | 0.22625 |

**TABLE 9**  Weighted normalized matrix

| Drivers | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | Si+ | Si− | CC$_i$ | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SDG 1 | 0.04071 | 0.03120 | 0.03845 | 0.02052 | 0.01915 | 0.02031 | 0.02898 | 0.03413 | 0.02 | 0.01 | 0.42 | 15 |
| SDG 2 | 0.03837 | 0.02796 | 0.03131 | 0.02280 | 0.01602 | 0.01705 | 0.02434 | 0.03631 | 0.03 | 0.01 | 0.29 | 17 |
| SDG 3 | 0.03983 | 0.03004 | 0.03505 | 0.02466 | 0.01915 | 0.02107 | 0.02828 | 0.03755 | 0.02 | 0.02 | 0.45 | 13 |
| SDG 4 | 0.03895 | 0.03027 | 0.03505 | 0.02404 | 0.01954 | 0.03411 | 0.03060 | 0.03444 | 0.02 | 0.02 | 0.58 | 6 |
| SDG 5 | 0.03866 | 0.03097 | 0.03811 | 0.02611 | 0.02051 | 0.03285 | 0.02133 | 0.02607 | 0.02 | 0.02 | 0.45 | 14 |
| SDG 6 | 0.03895 | 0.02958 | 0.03131 | 0.01969 | 0.01817 | 0.02307 | 0.03176 | 0.04468 | 0.02 | 0.02 | 0.52 | 10 |
| SDG 7 | 0.04012 | 0.02796 | 0.03437 | 0.02300 | 0.01817 | 0.02483 | 0.03176 | 0.04375 | 0.02 | 0.02 | 0.58 | 7 |
| SDG 8 | 0.04159 | 0.02981 | 0.03607 | 0.02155 | 0.02012 | 0.02558 | 0.02712 | 0.03010 | 0.02 | 0.01 | 0.39 | 16 |
| SDG 9 | 0.03807 | 0.02981 | 0.04083 | 0.02176 | 0.02188 | 0.02733 | 0.03338 | 0.03972 | 0.01 | 0.02 | 0.67 | **2** |
| SDG 10 | 0.04042 | 0.02912 | 0.03947 | 0.02487 | 0.02149 | 0.03160 | 0.02573 | 0.02793 | 0.02 | 0.02 | 0.49 | 11 |
| SDG 11 | 0.04100 | 0.02935 | 0.03709 | 0.02590 | 0.01895 | 0.02282 | 0.03083 | 0.04406 | 0.02 | 0.02 | 0.60 | 5 |
| SDG 12 | 0.03807 | 0.02750 | 0.03505 | 0.02508 | 0.01856 | 0.02307 | 0.02689 | 0.04437 | 0.02 | 0.02 | 0.54 | 9 |
| SDG 13 | 0.03837 | 0.03027 | 0.03743 | 0.02694 | 0.01934 | 0.02307 | 0.03037 | 0.04468 | 0.02 | 0.02 | 0.61 | 4 |
| SDG 14 | 0.03719 | 0.02820 | 0.03471 | 0.02508 | 0.01876 | 0.02182 | 0.03060 | 0.04437 | 0.02 | 0.02 | 0.55 | 8 |
| SDG 15 | 0.04012 | 0.02773 | 0.03709 | 0.02570 | 0.01973 | 0.02382 | 0.03037 | 0.04437 | 0.02 | 0.02 | 0.61 | **3** |
| SDG 16 | 0.04217 | 0.03074 | 0.04560 | 0.02466 | 0.02423 | 0.02708 | 0.03176 | 0.04065 | 0.01 | 0.03 | 0.76 | **1** |
| SDG 17 | 0.03895 | 0.02820 | 0.03981 | 0.01886 | 0.01954 | 0.02232 | 0.02805 | 0.03631 | 0.02 | 0.02 | 0.46 | 12 |
| V+ | 0.04217 | 0.03120 | 0.04560 | 0.02694 | 0.02423 | 0.03411 | 0.03338 | 0.04468 | | | | |
| V+ | 0.03719 | 0.02750 | 0.03131 | 0.01886 | 0.01602 | 0.01705 | 0.02133 | 0.02607 | | | | |

systematic and robust analysis of the SDGs and their interactions, as well as how they might play out in different contexts, could greatly advance national SDGs implementation (Nilsson, 2017). The adoption of the 2030 Agenda for Sustainable Development (UN, 2016) signaled a paradigm change in global development policy and collaboration (Nilsson, 2017). As a result, sustainable development has become the central focus of global collaboration (Sachs, 2015). Therefore, the role of vertical and horizontal supply chain collaboration is becoming substantial for supply chains to eliminate the fragility, uncertainty, and complexity toward achieving SDGs.

# 6 | IMPLICATIONS

The results demonstrate that D1 (economic sustainability) is the best driver that plays a vital role in accomplishing SDGs between all eight drivers, implying that attaining SDGs is becoming useless without financial aid as well as support. As a result, organizations must pay close attention to financial elements to make a real effect on LMICs because economic sustainability is vital to alleviate the detrimental impact of global inequality while simultaneously enhancing countries' acceptance of the SDGs (Van Niekerk, 2020). This driver is directly connected with SDG 8 (UN, 2016), which focuses on sustaining inclusive and sustainable economic growth with productive and decent working conditions for all, and this target connects country-level economic sustainability to individual-level work dignity (Leal Filho et al., 2019). Therefore, we can claim that achieving economic sustainability is the building block for realizing the other SDGs. Furthermore, D8 (environmental sustainability), D3 (supply chain connectivity), and D2 (policy and regulations) were found as the following important drivers after D1 (economic sustainability), respectively. The transition to SSCSC will have a significant positive impact on environmental sustainability since the cradle-to-cradle system of CE refuses the industrial paradigm of "take-make-dispose" (Averina et al., 2021; Blomsma & Brennan, 2017). Even though most of the SDGs address climate change and environmental sustainability challenges directly or indirectly, SDG 13 focuses specifically on tackling climate change and its consequences (Leal Filho et al., 2019; UN, 2016). Also, supply chain connectivity, which increases the productivity of the systems, operational efficiency, data management, continuous production, energy waste elimination, and so on (Kayikci, Kazancoglu, Lafci, Gozacan-Chase, & Mangla, 2021), is substantial for realizing SDGs. Particularly, an open and connective platform enabling a network through international cooperation as well as collaboration across vertical and horizontal supply chain participants is an essential supporter of SDG achievement. In this context, companies need to focus on SC connectivity as a driver to achieve SDGs because it is becoming more effective, efficient, reactive (Luthra et al., 2020), and intelligent because of upcoming smart technology breakthroughs. Furthermore, policies and regulations that force companies to adopt smart technologies and sustainability principles for circularity purposes in the supply chain are a requirement for SDG achievement. Policies, subsidies, regulations, and incentives pursued by the government are required for the adoption of SDGs and their effective implementation at a local, regional, and global level.

# 7 | CONCLUSION

This study broadly presents a holistic approach that combines the current literature, empirical evidence, and theoretical background. This study also discusses the need for and importance of examining the drivers of the SSCSC for achieving SDGs in LMIC. For this purpose, the current literature systematically reviewed and identified drivers that combine sustainability, CE, and I4.0, and drivers that play an important role in achieving the SDGs. Eight drivers were determined by group discussion. In addition, those determined drivers were investigated by stakeholder theory as a theoretical background to underline the importance of the collaboration among supply chain tiers in achieving SDGs in LMIC. Stakeholder theory was used in preparing the conceptual background of this paper because achieving the SDGs is a complex task and not easy to do. It requires the full collaboration of the entire stakeholders in the SSCSC. Switching supply chain networks into more SSCSC manners requires a well understanding of this theory. Therefore, the main purpose of using this theory is about understanding the dynamics of SSCSC and its stakeholders and better conceptualizing the drivers for effective implementation of the SDGs. Furthermore, as empirical evidence, predetermined drivers were evaluated by 16 industry experts, which are composed of eight different backgrounds in the textile industry, in a structured format. The BWM approach and TOPSIS were used as a solution methodology for this paper. The BWM was applied to predetermined eight drivers to identify the importance of these drivers through achieving SDGs in LMIC. On the other hand, these eight drivers were evaluated depending upon their effect on 17 SDGs via the TOPSIS method.

The results of the study are twofold. First, the drivers were analyzed via the BWM method. The results of the BWM reveal that D1 (economic sustainability) is the best driver that has a key role in achieving SDGs among all eight drivers, which means without financial assistance and support, achieving SDGs is becoming ineffective. Thus, required attention needs to be given to organizations in terms of financial aspects to create a meaningful difference in LMIC Furthermore, D8 (environmental sustainability), D3 (supply chain connectivity), and D2 (policy and regulations) were found as the following important drivers after D1 (economic sustainability), respectively. Especially, an open and connective platform that provides a network and international cooperation and collaboration among vertical and horizontal members of the supply chain is an important promoter to achieve SDGs. Also, D5 (organizational competency) was ranked as the worst or the least important driver among these eight drivers. After identifying the best and worst drivers to achieve SDGs in LMIC, the TOPSIS method was applied to the study to determine which SDG specification these drivers support more. From the analysis of which SDG is supported by the determined eight drivers, SDG 16 (peace, justice, and strong institutions) were found as the most supported SDG by the drivers. Also, the weights and ranking of the most supported SDGs were followed by SDG 9 (industry, innovation, and infrastructure), SDG 15 (life on land), and SDG 13 (climate action), respectively. Depending on the weights and rankings, SDG 1 (no poverty) is the least supported SDG by the determined eight drivers. Also, contrary to expectations, surprisingly SDG 17 (global partnerships for sustainable development) did not rank high in TOPSIS. To examine the reason for this, a study on barriers can also be described as future research. Thus, the barriers that cause SDG 17 not to be high ranked can be examined.

The results of this study contribute to the literature by providing a holistic understanding of achieving SDGs in LMIC and providing vertical and horizontal supply chain collaboration for this purpose.

Identifying, analyzing, and ranking the eight drivers and the SDGs affected by these factors facilitate industry practitioners to identify which drivers they should adopt to achieve a specific SDG and take required remediation action. Therefore, this study assists industry experts, practitioners, and managers to understand which drivers should be adopted by organizations to support SDGs in LMIC. Also, effective, and supportive government regulations, policies, conductive legal systems, effective executions related to environmental regulations, and so on are some of the key drivers for setting a roadmap to achieve SDGs for industry experts, practitioners, and managers. Moreover, some policies and regulations related to consumer consumption habits toward sustainability behaviors, tax reductions, and financial subsidies can be influential for organizations to direct them to adopt SDGs. The limitations of this research, the presented study focuses only on Turkey as LMIC and only the textile industry is considered as a numerical example. Future research can focus on this topic with a broader scope. By defining the drivers, this research concentrates on only the WoS database which can be also defined as a limitation. Furthermore, the drivers can be also analyzed by using Total Interpretive Structural Modelling to construct a hierarchical model by analyzing the contextual interrelationships between the identified drivers as the next step. Moreover, another multiple-criteria decision-making method, DEMATEL can be utilized to discover the cause-effect relationships between the drivers.

## ORCID

*Yasanur Kayikci* https://orcid.org/0000-0003-2406-3164
*Yigit Kazancoglu* https://orcid.org/0000-0001-9199-671X

## REFERENCES

Agrawal, R., & Vinodh, S. (2021). Prioritisation of drivers of sustainable additive manufacturing using best worst method. *International Journal of Sustainable Engineering*, *14*(6), 1587–1603. https://doi.org/10.1080/19397038.2021.1944396

Alves, M. D. C. G., & Rodrigues, M. M. M. (2019). Corporate social responsibility: An integrative approach in the mining industry. In *Corporate social responsibility: Concepts, methodologies, tools, and applications* (pp. 1135–1154). IGI Global. https://doi.org/10.4018/978-1-5225-6192-7.ch058

Andrews, D. (2015). The circular economy, design thinking and education for sustainability. *Local Economy*, *30*(3), 305–315. https://doi.org/10.1177/0269094215578226

Averina, E., Frishammar, J., & Parida, V. (2021). Assessing sustainability opportunities for circular business models. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.2964

Badraoui, I., Boulaksil, Y., Saikouk, T., & Van der Vorst, G. A. J. (2021). The influence of the institutional context on interfirm relationships: A comparative study between low-and high-income countries. *Economics Bulletin*, *41*(2), 802–815.

Bag, S., Telukdarie, A., Pretorius, J. C., & Gupta, S. (2018). Industry 4.0 and supply chain sustainability: Framework and future research directions. *Benchmarking: An International Journal*, *28*(5), 1410–1450. https://doi.org/10.1108/BIJ-03-2018-0056

Bai, C., Sarkis, J., & Dou, Y. (2015). Corporate sustainability development in China: Review and analysis. *Industrial Management & Data Systems*, *1115*(1), 5–40. https://doi.org/10.1108/IMDS-09-2014-0258

Barić, A. (2017). Corporate social responsibility and stakeholders: Review of the last decade (2006-2015). *Business Systems Research: International Journal of the Society for Advancing Innovation and Research in Economy*, *8*(1), 133–146. https://doi.org/10.1515/bsrj-2017-0011

Bassetti, T., Blasi, S., & Sedita, S. R. (2021). The management of sustainable development: A longitudinal analysis of the effects of environmental performance on economic performance. *Business Strategy and the Environment*, *30*(1), 21–37. https://doi.org/10.1002/bse.2607

Batista, L., Bourlakis, M., Liu, Y., Smart, P., & Sohal, A. (2018). Supply chain operations for a circular economy. *Production Planning andControl*, *29*(6), 419–424. https://doi.org/10.1080/09537287.2018.1449267

Bellantuono, N., Pontrandolfo, P., & Scozzi, B. (2016). Capturing the Stakeholders' view in sustainability reporting: A novel approach. *Sustainability*, *8*(4), 379. 1–12. https://doi.org/10.3390/su8040379

Bhaskaran, S., Polonsky, M., Cary, J., & Fernandez, S. (2006). Environmentally sustainable food production and marketing: Opportunity or hype? *British Food Journal*, *108*(8), 677–690. https://doi.org/10.1108/00070700610682355

Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology*, *21*(3), 603–614. https://doi.org/10.1002/bse.2964

Bonilla, S. H., Silva, H. R., Terra da Silva, M., Franco Gonçalves, R., & Sacomano, J. B. (2018). Industry 4.0 and sustainability implications: A scenario-based analysis of the impacts and challenges. *Sustainability*, *10*(10), 3740. https://doi.org/10.3390/su10103740

Brandenburger, A. M., & Nalebuff, B. J. (1996). Co-opetition: A revolutionary mindset that combines competition and co-operation: The theory strategy that's changing the game of business. Boston.

Brown, A. S. (2009). Conflict on the green. *Mechanical Engineering*, *131*(3), 42–45.

Burritt, R. L., & Schaltegger, S. (2010). Sustainability accounting and reporting: Fad or trend? *Accounting, Auditing & Accountability Journal*, *23*(7), 829–846. https://doi.org/10.1108/09513571011080144

Butner, K. (2010). The smarter supply chain of the future. *Strategy & Leadership*, *38*(1), 22–31. https://doi.org/10.1108/10878571011009859

Carroll, A. B., & Brown, J. A. (2018). Corporate social responsibility: A review of current concepts, research, and issues. *Corporate Social Responsibility (Business and Society)*, *360*(2), 39–69. https://doi.org/10.1108/S2514-175920180000002002

Carter, C. R., Ellram, L. M., & Tate, W. L. (2007). Structure and influence: A logistics management application of social network analysis. *Journal of Business Logistics*, *28*(1), 137–168. https://doi.org/10.1002/j.2158-1592.2007.tb00235.x

Carter, C. R., & Jennings, M. M. (2002). Social responsibility and supply chain relationships. *Transportation Research Part E: Logistics and Transportation Review*, *38*(1), 37–52. https://doi.org/10.1016/S1366-5545(01)00008-4

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: Moving toward new theory. *International Journal of Physical Distribution and Logistics Management*, *38*(5), 360–387. https://doi.org/10.1108/09600030810882816

Chen, T. L., Kim, H., Pan, S. Y., Tseng, P. C., Lin, Y. P., & Chiang, P. C. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. *Science of the Total Environment*, *716*, 136998. https://doi.org/10.1016/j.scitotenv.2020.136998

Chien, M. K., & Shih, L. H. (2007). An empirical study of the implementation of green supply chain management practices in the Lectrical and electronic industry and their relation to organizational performances.

*International journal of Environmental Science and Technology*, *4*(3), 383–394. http://www.bioline.org.br/pdf?st07049

Clark, G. L., Feiner, A., & Viehs, M. (2015). From the stockholder to the stakeholder: How sustainability can drive financial outperformance. *Available at SSRN 2508281*.

Collier, Z. A., Bates, M. E., Wood, M. D., & Linkov, I. (2014). Stakeholder Engagement in Dredged Material Management Decisions. *Science of the Total Environment*, *496*, 248–256. https://doi.org/10.1016/j.scitotenv.2014.07.044

Cox, A., Chicksand, D., & Palmer, M. (2007). Stairways to heaven or treadmills to oblivion? Creating sustainable strategies in red meat supply chains. *British Food Journal*, *109*(9), 689–720. https://doi.org/10.1108/00070700710780689

Dantas, T. E., De-Souza, E. D., Destro, I. R., Hammes, G., Rodriguez, C. M. T., & Soares, S. R. (2021). How the combination of circular economy and industry 4.0 can contribute towards achieving the sustainable development goals. *Sustainable Production and Consumption*, *26*, 213–227. https://doi.org/10.1016/j.spc.2020.10.005

Desrochers, P. (2001). Cities and industrial Symbiosis: Some historical perspectives and policy implications. *Journal of Industrial Ecology*, *5*(4), 29–44. https://doi.org/10.1162/10881980160084024

Diabat, A., Kannan, D., & Mathiyazhagan, K. (2014). Analysis of enablers for implementation of sustainable supply chain management–a textile case. *Journal of Cleaner Production*, *83*, 391–403. https://doi.org/10.1016/j.jclepro.2014.06.081

Dong, L., Fujita, T., Dai, M., Geng, Y., Ren, J., Fujii, M., Wang, Y., & Ohnishi, S. (2016). Towards preventative eco-industrial development: An industrial and urban Symbiosis case in one typical Industrial City in China. *Journal of Cleaner Production*, *114*, 387–400. https://doi.org/10.1016/j.jclepro.2015.05.015

Dong, S., Burritt, R., & Qian, W. (2014). Salient stakeholders in corporate social responsibility reporting by Chinese mining and minerals companies. *Journal of Cleaner Production*, *84*, 59–69. https://doi.org/10.1016/j.jclepro.2014.01.012

Duan, Y., Aloysius, J. A., & Mollenkopf, D. A. (2021). Communicating supply chain sustainability: Transparency and framing effects. *International Journal of Physical Distribution and Logistics Management*, *52*(1), 68–87. https://doi.org/10.1108/IJPDLM-04-2020-0107

Dwyer, R., Lamond, D., Molina-Azorín, J. F., Claver-Cortés, E., López-Gamero, M. D., & Tarí, J. J. (2009). Green management and financial performance: A literature review. *Management Decision*, *47*, 1080–1100. https://doi.org/10.1108/00251740910978313

Elia, G., Margherita, A., & Petti, C. (2020). Building responses to sustainable development challenges: A multistakeholder collaboration framework and application to climate change. *Business Strategy and the Environment*, *29*(6), 2465–2478. https://doi.org/10.1002/bse.2514

Ellen MacArthur Foundation. (2013). *Towards the circular economy, economic and business rationale for an accelerated transition* (pp. 21–34). Cowes, UK.

European Commission (EC). (2014). European Resource Efficiency Platform (EREP): Manifesto and policy recommendations. Retrieved 27 August 2021 from https://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendations_31-03-2014.pdf

Fabbe-Costes, N., Roussat, C., & Colin, J. (2011). Future sustainable supply chains: What should companies scan? *International Journal of Physical Distribution and Logistics Management*, *41*(3), 228–252. https://doi.org/10.1108/09600031111123778

Faisal, M. N. (2010). Sustainable supply chains: A study of interaction among the enablers. *Business Process Management, Journal*,*16*(3), 508–529. https://doi.org/10.1108/14637151011049476

Fallahpour, A., Amindoust, A., Antuchevičienė, J., & Yazdani, M. (2017). Nonlinear genetic-based model for supplier selection: A comparative study. *Technological and Economic Development of Economy*, *23*(1), 178–195. https://doi.org/10.3846/20294913.2016.1189461

Farooque, M., Zhang, A., Thürer, M., Qu, T., & Huisingh, D. (2019). Circular supply chain management: A definition and structured literature review. *Journal of Cleaner Production*, *228*, 882–900. https://doi.org/10.1016/j.jclepro.2019.04.303

Fatimah, Y. A., Govindan, K., Murniningsih, R., & Setiawan, A. (2020). Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia. *Journal of Cleaner Production*, *269*, 122263. https://doi.org/10.1016/j.jclepro.2020.122263

Fettermann, D. C., Cavalcante, C. G. S., Almeida, T. D. D., & Tortorella, G. L. (2018). How does industry 4.0 contribute to operations management? *Journal of Industrial and Production Engineering*, *35*(4), 255–268. https://doi.org/10.1080/21681015.2018.1462863

Figge, F., Hahn, T., Schaltegger, S., & Wagner, M. (2002). The sustainability balanced scorecard–linking sustainability management to business strategy. *Business Strategy and the Environment*, *11*(5), 269–284. https://doi.org/10.1002/bse.339

Fowler, A., & Biekart, K. (2017). Multi-stakeholder initiatives for sustainable development goals: The importance of interlocutors. *Public Administration and Development*, *37*(2), 81–93. https://doi.org/10.1002/pad.1795

Freeman, R. E. (1994). The politics of stakeholder theory: Some future directions. *Business Ethics Quarterly*, *4*, 409–421. https://doi.org/10.2307/3857340

Gabzdylova, B., Raffensperger, J. F., & Castka, P. (2009). Sustainability in the New Zealand wine industry: Drivers, stakeholders and practices. *Journal of Cleaner Production*, *17*(11), 992–998. https://doi.org/10.1016/j.jclepro.2009.02.015

Geffen, C., & Rothenberg, S. (2000). Sustainable development across firm boundaries: The critical role of suppliers in environmental innovation. *International Journal of Operations & Production Management*, *20*(2), 166–186. https://doi.org/10.1108/01443570010304242

Geldermann, J., Treitz, M., & Rentz, O. (2007). Towards sustainable production networks. *International Journal of Production Research*, *45*(18–19), 4207–4224. https://doi.org/10.1080/00207540701440014

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. *Omega*, *66*, 344–357. https://doi.org/10.1016/j.omega.2015.05.015

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. https://doi.org/10.1016/j.jclepro.2015.09.007

Ghoushchi, S. J., Yousefi, S., & Khazaeili, M. (2019). An extended FMEA approach based on the Z-MOORA and fuzzy BWM for prioritization of failures. *Applied Soft Computing*, *81*, 105505. https://doi.org/10.1016/j.asoc.2019.105505

Gladwin, T. N., Kennelly, J. J., & Krause, T. S. (1995). Shifting paradigms for sustainable development: Implications for management theory and research. *Academy of Management Review*, *20*(4), 874–907. https://doi.org/10.5465/amr.1995.9512280024

Goyal, S., Esposito, M., & Kapoor, A. (2018). Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms. *Thunderbird International Business Review*, *60*(5), 729–740. https://doi.org/10.1002/tie.21883

Gozacan, N., & Lafci, C. (2020). Evaluation of key performance indicators of logistics firms. *Logistics and Sustainable Transport*, *11*(1), 24–32. https://doi.org/10.2478/jlst-2020-0002

Guide, V. D. R. Jr., Teunter, R. H., & Van Wassenhove, L. N. (2003). Matching demand and supply to maximize profits from remanufacturing. *Manufacturing and Service Operations Management*, *5*(4), 303–316. https://doi.org/10.1287/msom.5.4.303.24883

Guide, V. D. R. Jr., & Van Wassenhove, L. N. (2009). OR FORUM—The evolution of closed-loop supply chain research. *Operations Research*, *57*(1), 10–18. https://doi.org/10.1287/opre.1080.0628

Guo, S., & Zhao, H. (2017). Fuzzy best-worst multi-criteria decision-making method and its applications. *Knowledge-Based Systems*, *121*, 23–31. https://doi.org/10.1016/j.knosys.2017.01.010

Gupta, S., Chen, H., Hazen, B. T., Kaur, S., & Gonzalez, E. D. S. (2019). Circular economy and big data analytics: A stakeholder perspective. *Technological Forecasting and Social Change*, *144*, 466–474. https://doi.org/10.1016/j.techfore.2018.06.030

Haseli, G., Sheikh, R., Wang, J., Tomaskova, H., & Tirkolaee, E. B. (2021). A novel approach for group decision making based on the best–worst method (G-bwm): Application to supply chain management. *Mathematics*, *9*(16), 1881. https://doi.org/10.3390/math9161881

Herazo, B., & Lizarralde, G. (2016). Understanding stakeholders approaches to sustainability in building projects. *Sustainable Cities and Society*, *26*, 240–254. https://doi.org/10.1016/j.scs.2016.05.019

Hermann, M., Pentek, T. & Otto, B. (2016). Design principles for Industrie 4.0 scenarios. In *2016 49th Hawaii International Conference on System Sciences (HICSS)* (pp. 3928–3937). IEEE. https://doi.org/10.1109/HICSS.2016.488

Hofmann, K. H., Theyel, G., & Wood, C. H. (2012). Identifying firm capabilities as drivers of environmental management and sustainability practices–evidence from small and medium-sized manufacturers. *Business Strategy and the Environment*, *21*(8), 530–545. https://doi.org/10.1002/bse.739

Hörisch, J., Freeman, R. E., & Schaltegger, S. (2014). Applying stakeholder theory in sustainability management: Links, similarities, dissimilarities, and a conceptual framework. *Organization and Environment*, *27*(4), 328–346. https://doi.org/10.1177/1086026614535786

Hussain, M. (2011). Modelling the enablers and alternatives for sustainable supply chain management (Doctoral dissertation, Concordia University).

Hwang, C. L., & Yoon, K. (1981). *Multiple attribute decision making: Methods and applications a state-of-the-art survey* (pp. 1–269). Springer. https://doi.org/10.1007/978-3-642-48318-9

Ilić, M., & Nikolić, M. (2016). Drivers for development of circular economy–a case study of Serbia. *Habitat International*, *56*, 191–200. https://doi.org/10.1016/j.habitatint.2016.06.003

Innes, J. E., & Booher, D. E. (2000). Indicators for sustainable communities: A strategy building on complexity theory and distributed intelligence. *Planning Theory & Practice*, *1*(2), 173–186. https://doi.org/10.1080/14649350020008378

Jain, S., Jain, N. K., & Metri, B. (2018). Strategic framework towards measuring a circular supply chain management. *Benchmarking: An International Journal*, *25*(8), 3238–3252. https://doi.org/10.1108/BIJ-11-2017-0304

Jamison, L., & Murdoch, H. (2004). *Taking the temperature: Ethical supply chain management*. Institute of Business Ethics.

Kagermann, H. (2015). Change Through Digitization—value Creation in the Age of Industry 4.0. In *Management of Permanent Change* (pp. 23–45). Springer Gabler. https://doi.org/10.1007/978-3-658-05014-6_2

Karim, R., & Karmaker, C. L. (2016). Machine selection by AHP and TOPSIS methods. *American Journal of Industrial Engineering*, *4*(1), 7–13. http://pubs.sciepub.com/ajie/4/1/2

Kayikci, Y., Gozacan, N., Lafci, C., & Kazancoglu, Y. (2021). A Conceptual Framework for Food Loss and Waste in Agri-Food Supply Chains: Circular Economy Perspective. In *Challenges and opportunities of circular economy in Agri-food sector* (pp. 41–53). Springer. https://doi.org/10.1007/978-981-16-3791-9_3

Kayikci, Y., Kazancoglu, Y., Lafci, C., & Gozacan, N. (2021). Exploring barriers to Smart and sustainable circular economy: The case of an automotive eco-cluster. *Journal of Cleaner Production*, *314*, 127920. https://doi.org/10.1016/j.jclepro.2021.127920

Kayikci, Y., Kazancoglu, Y., Lafci, C., Gozacan-Chase, N., & Mangla, S. K. (2021). Smart circular supply chains to achieving SDGs for post-pandemic preparedness. *Journal of Enterprise Information Management*, *35*(1), 237–265. https://doi.org/10.1108/JEIM-06-2021-0271

Khosravi, F., & Izbirak, G. (2019). A stakeholder perspective of social sustainability measurement in healthcare supply chain management. *Sustainable Cities and Society*, *50*, 101681. https://doi.org/10.1016/j.scs.2019.101681

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Klimley, A. (2005). Sustainable development becoming integral part of business strategy. *Research-Technology Management*, *48*(5), 2.

Kok, L., Wurpel, G., & Ten Wolde, A. (2013). Unleashing the power of the circular economy. *Report by IMSA Amsterdam for Circle Economy*.

Kouhizadeh, M., Zhu, Q., & Sarkis, J. (2020). Blockchain and the circular economy: Potential tensions and critical reflections from practice. *Production Planning and Control*, *31*(11–12), 950–966. https://doi.org/10.1080/09537287.2019.1695925

Kumar, N., Mathiyazhagan, K., & Mathivathanan, D. (2020). Modelling the interrelationship between factors for adoption of sustainable lean manufacturing: A business case from the Indian automobile industry. *International Journal of Sustainable Engineering*, *13*(2), 93–107. https://doi.org/10.1080/19397038.2019.1706662

Lacy, P., & Rutqvist, J. (2015). Five Circular Capabilities for Driving Value. In *Waste to wealth* (pp. 148–167). Palgrave Macmillan. https://doi.org/10.1057/9781137530707_11

Laguir, L., Laguir, I., & Tchemeni, E. (2019). Implementing CSR activities through management control systems: A formal and informal control perspective. *Accounting, Auditing & Accountability Journal*, *32*(2), 531–555. https://doi.org/10.1108/AAAJ-05-2016-2566

Leal Filho, W., Tripathi, S. K., Andrade Guerra, J. B. S. O. D., Giné-Garriga, R., Orlovic Lovren, V., & Willats, J. (2019). Using the sustainable development goals towards a better understanding of sustainability challenges. *International Journal of Sustainable Development and World Ecology*, *26*(2), 179–190. https://doi.org/10.1080/13504509.2018.1505674

Lee, H. L. (2008). Embedding sustainability: Lessons from the front line. *International Commerce Review*, *8*(1), 10–20. https://doi.org/10.1007/s12146-008-0026-4

Li, Y., & Mathiyazhagan, K. (2018). Application of DEMATEL approach to identify the influential indicators towards sustainable supply chain adoption in the auto components manufacturing sector. *Journal of Cleaner Production*, *172*, 2931–2941. https://doi.org/10.1016/j.jclepro.2017.11.120

Liao, Y., Deschamps, F., Loures, E. D. F. R., & Ramos, L. F. P. (2017). Past, present and future of industry 4.0-a systematic literature review and research agenda proposal. *International Journal of Production Research*, *55*(12), 3609–3629. https://doi.org/10.1080/00207543.2017.1308576

Liboni, L. B., Cezarino, L. O., Jabbour, C. J. C., Oliveira, B. G., & Stefanelli, N. O. (2019). Smart industry and the pathways to HRM 4.0: Implications for SCM. *Supply Chain Management: An International Journal*, *24*(1), 124–146. https://doi.org/10.1108/SCM-03-2018-0150

Lin, K. C., Shyu, J. Z., & Ding, K. (2017). A cross-strait comparison of innovation policy under industry 4.0 and sustainability development transition. *Sustainability*, *9*(5), 786. https://doi.org/10.3390/su9050786

Linder, M., & Williander, M. (2017). Circular business model innovation: Inherent uncertainties. *Business Strategy and the Environment*, *26*(2), 182–196. https://doi.org/10.1002/bse.1906

Linnenluecke, M. K., Griffiths, A., & Winn, M. (2012). Extreme weather events and the critical importance of anticipatory adaptation and organizational resilience in responding to impacts. *Business Strategy and the Environment*, *21*(1), 17–32. https://doi.org/10.1002/bse.708

Liu, J., Feng, Y., Zhu, Q., & Sarkis, J. (2018). Green supply chain management and the circular economy: Reviewing theory for advancement of both fields. *International Journal of Physical Distribution and Logistics Management*, *48*(8), 794–817. https://doi.org/10.1108/IJPDLM-01-2017-0049

Lopes de Sousa Jabbour, A. B., Jabbour, C. J. C., Godinho Filho, M., & Roubaud, D. (2018). Industry 4.0 and the circular economy: A proposed research agenda and original roadmap for sustainable operations. *Annals of Operations Research*, 270(1), 273–286. https://doi.org/10.1007/s10479-018-2772-8

Luthra, S., Kumar, A., Zavadskas, E. K., Mangla, S. K., & Garza-Reyes, J. A. (2020). Industry 4.0 as an enabler of sustainability diffusion in supply chain: An analysis of influential strength of drivers in an emerging economy. *International Journal of Production Research*, 58(5), 1505–1521. https://doi.org/10.1080/00207543.2019.1660828

Luthra, S., & Mangla, S. K. (2018). Evaluating challenges to industry 4.0 initiatives for supply chain sustainability in emerging economies. *Process Safety and Environmental Protection*, 117, 168–179. https://doi.org/10.1016/j.psep.2018.04.018

Marshall, R. S., Cordano, M., & Silverman, M. (2005). Exploring individual and institutional drivers of proactive environmentalism in the US wine industry. *Business Strategy and the Environment*, 14(2), 92–109. https://doi.org/10.1002/bse.433

Masi, D., Day, S., & Godsell, J. (2017). Supply chain configurations in the circular economy: A systematic literature review. *Sustainability*, 9(9), 1602. https://doi.org/10.3390/su9091602

Mathews, J. A., & Tan, H. (2011). Progress toward a circular economy in China: The drivers (and inhibitors) of eco-industrial initiative. *Journal of Industrial Ecology*, 15(3), 435–457. https://doi.org/10.1111/j.1530-9290.2011.00332.x

McKeown, R., Hopkins, C. A., Rizi, R., & Chrystalbridge, M. (2002). *Education for sustainable development toolkit* (2nd ed., pp. 1–142). Energy, Environment and Resources Center, University of Tennessee. http://kpe-kardits.kar.sch.gr/Aiforia/esd_toolkit_v2.pdf

Meherishi, L., Narayana, S. A., & Ranjani, K. S. (2019). Sustainable packaging for supply chain Management in the Circular Economy: A review. *Journal of Cleaner Production*, 237, 117582. https://doi.org/10.1016/j.jclepro.2019.07.057

Merkel, L., Atug, J., Merhar, L., Schultz, C., Braunreuther, S., & Reinhart, G. (2017). Teaching Smart production: An insight into the learning factory for cyber-physical production systems (LVP). *Procedia Manufacturing*, 9, 269–274. https://doi.org/10.1016/j.promfg.2017.04.034

Morali, O., & Searcy, C. (2013). A review of sustainable supply chain management practices in Canada. *Journal of Business Ethics*, 117(3), 635–658. https://doi.org/10.1007/s10551-012-1539-4

Moreno, M., Braithwaite, N. & Cooper, T. (2014). Moving beyond the circular economy. Proceedings of Going Green-CARE Innovation 2014, Vienna, Austria, 17-20 November 2014, 1–10.

Morseletto, P. (2020). Targets for a circular economy. *Resources, Conservation and Recycling*, 153, 104553. https://doi.org/10.1016/j.resconrec.2019.104553

Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in industry 4.0. *Technological Forecasting and Social Change*, 132, 2–17. https://doi.org/10.1016/j.techfore.2017.12.019

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. https://doi.org/10.1007/s10551-015-2693-2

Murthy, S. R. & Evans, S. (2016). Four Arrangements of Circular Economy at the Level of Supply Chains. 3rd International conference on green supply chain, Loughborough University in London, UK, 10–13 July 2016.

Nasir, S. B., Ahmed, T., Karmaker, C. L., Ali, S. M., Paul, S. K., & Majumdar, A. (2021). Supply chain viability in the context of COVID-19 pandemic in small and medium-sized enterprises: Implications for sustainable development goals. *Journal of Enterprise Information Management*, 35(1), 100–124. https://doi.org/10.1108/JEIM-02-2021-0091

Nilsson, M. (2017). *Important interactions among the sustainable development goals under review at the high-level political Forum 2017*. Stockholm Environment Institute, Working Paper 2017-06. https://mediamanager.sei.org/documents/Publications/SEI-WP-2017-06-Nilsson-SDG-interact-HLPF2017.pdf

Okorie, O., Salonitis, K., Charnley, F., Moreno, M., Turner, C., & Tiwari, A. (2018). Digitisation and the circular economy: A Review of Current Research and Future Trends. *Energies*, 11(11), 3009. https://doi.org/10.3390/en11113009

Perey, R., Benn, S., Agarwal, R., & Edwards, M. (2018). The place of waste: Changing business value for the circular economy. *Business Strategy and the Environment*, 27(5), 631–642. https://doi.org/10.1002/bse.2068

Perrini, F., & Tencati, A. (2006). Sustainability and stakeholder management: The need for new corporate performance evaluation and reporting systems. *Business Strategy and the Environment*, 15(5), 296–308. https://doi.org/10.1002/bse.538

Pfohl, H. C., Yahsi, B., & Kurnaz, T. (2017). Concept and Diffusion-factors of Industry 4.0 in the Supply Chain. In *Dynamics in logistics* (pp. 381–390). Springer. https://doi.org/10.1007/978-3-319-45117-6_33

Qian, W., Tilt, C., Dissanayake, D., & Kuruppu, S. (2020). Motivations and impacts of sustainability reporting in the indo-Pacific region: Normative and instrumental stakeholder approaches. *Business Strategy and the Environment*, 29(8), 3370–3384. https://doi.org/10.1002/bse.2577

Queiroz, M. M., Wamba, S. F., Machado, M. C., & Telles, R. (2020). Smart production systems drivers for business process management improvement: An integrative framework. *Business Process Management Journal*, 26(5), 1075–1092. https://doi.org/10.1108/BPMJ-03-2019-0134

Quezada, L. E., Chiu, A. S. F., Gouvea da Costa, S. E., & Tan, K. H. (2017). Operational excellence towards sustainable development goals through industry 4.0. *International Journal of Production Economics*, 190, 1–2. https://doi.org/10.1016/j.ijpe.2017.06.014

Rajput, S., & Singh, S. P. (2019). Connecting circular economy and industry 4.0. *International Journal of Information Management*, 49, 98–113. https://doi.org/10.1016/j.ijinfomgt.2019.03.002

Reddy, A. A., Rani, C. R., Cadman, T., Kumar, S. N., & Reddy, A. N. (2016). Towards sustainable indicators of food and nutritional outcomes in India. *World Journal of Science, Technology and Sustainable Development*, 13(2), 128–142. https://doi.org/10.1108/WJSTSD-10-2015-0049

Rezaei, J. (2015a). Best-worst multi-criteria decision-making method. *Omega*, 53, 49–57. https://doi.org/10.1016/j.omega.2014.11.009

Rezaei, J. (2015b). A systematic review of multi-criteria decision-making applications in reverse logistics. *Transportation Research Procedia*, 10, 766–776. https://doi.org/10.1016/j.trpro.2015.09.030

Rice, S. (2003). Commitment to excellence: Practical approaches to environmental leadership. *Environmental Quality Management*, 12(4), 9–22. https://doi.org/10.1002/tqem.10082

Roberts, S. (2003). Supply chain specific? Understanding the patchy success of ethical sourcing initiatives. *Journal of Business Ethics*, 44(2), 159–170. https://doi.org/10.1023/A:1023395631811

Roszkowska, E. (2011). Multi-criteria decision making models by applying the TOPSIS method to crisp and interval data. *Multiple Criteria Decision Making/University of Economics in Katowice*, 6(1), 200–230. https://mcdm.ue.katowice.pl/files/papers/mcdm11(6)_11.pdf

Sachs, J. D. (2015). Achieving the sustainable development goals. *Journal of International Business Ethics*, 8(2), 53–62. http://www.cibe.org.cn/uploadfile/2016/2016_04_14_11193686.pdf#page=53

Sarkis, J., Gonzalez-Torre, P., & Adenso-Diaz, B. (2010). Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. *Journal of Operations Management*, 28(2), 163–176. https://doi.org/10.1016/j.jom.2009.10.001

Savage, G. T., Bunn, M. D., Gray, B., Xiao, Q., Wang, S., Wilson, E. J., & Williams, E. S. (2010). Stakeholder collaboration: Implications for stakeholder theory and practice. *Journal of Business Ethics*, *96*(1), 21–26. https://doi.org/10.1007/s10551-011-0939-1

Savtschenko, M., Schulte, F., & Voß, S. (2017). IT governance for cyber-physical systems: The case of Industry 4.0. In A. Marcus & W. Wang (Eds.), *Design, user experience, and usability: Theory, methodology, and management. DUXU 2017*. Lecture Notes in Computer Science (Vol. 10288, pp. 667–676). Springer. https://doi.org/10.1007/978-3-319-58634-2_48

Schroeder, P., Anggraeni, K., & Weber, U. (2019). The relevance of circular economy practices to the sustainable development goals. *Journal of Industrial Ecology*, *23*(1), 77–95. https://doi.org/10.1111/jiec.12732

Schuster, K., Groß, K., Vossen, R., Richert, A., & Jeschke, S. (2016). Preparing for industry 4.0–collaborative virtual learning environments in engineering education. In *Engineering education 4.0* (pp. 477–487). Springer. https://doi.org/10.1007/978-3-319-46916-4_36

Shi, L., Wu, K. J., & Tseng, M. L. (2017). Improving corporate sustainable development by using an interdependent closed-loop hierarchical structure. *Resources, Conservation and Recycling*, *119*, 24–35. https://doi.org/10.1016/j.resconrec.2016.08.014

Stahel, W. R. (2013). Policy for material efficiency—Sustainable taxation as a departure from the throwaway society. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *371*(1986), 20110567. https://doi.org/10.1098/rsta.2011.0567

Swee, S. K., Sev, V. N. & Amer, Y. (2010). Challenges in implementing sustainable supply chain within a collaborative manufacturing network. In 2010 8th International Conference on Supply Chain Management and Information (pp. 1–8). IEEE.

Tapaninaho, R., & Heikkinen, A. (2022). Value creation in circular economy business for sustainability: A stakeholder relationship perspective. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.3002

Thornton, G. (2017). India's readiness for industry 4.0: A focus on automotive sector. Grand Thornton and Confederation of Indian Industry. White Paper. Available at: https://www.gita.org.in/Attachments/Reports/India%E2%80%99s%20Readiness%20for%20Industry%204.0.pdf, last accessed on 22.12.2020.

Tseng, M. L., Ha, H. M., Wu, K. J., & Xue, B. (2021). Healthcare industry circular supply chain collaboration in Vietnam: Vision and learning influences on connection in a circular supply chain and circularity business model. *International Journal of Logistics Research and Applications*, 1–26. https://doi.org/10.1080/13675567.2021.1923671

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., & Valkokari, P. (2019). Unlocking circular business: A framework of barriers and drivers. *Journal of Cleaner Production*, *212*, 90–98. https://doi.org/10.1016/j.jclepro.2018.11.202

Turker, D. (2015). An analysis of corporate social responsibility in the Turkish business context. In S. Idowu, R. Schmidpeter, & M. Fifka (Eds.), *Corporate social responsibility in Europe* CSR, Sustainability, Ethics & Governance (pp. 483–499). Springer. https://doi.org/10.1007/978-3-319-13566-3_26

United Nations. (2016). *Global sustainable development report 2016* (2016th ed.). Department of Economic and Social Affairs, United Nations. https://sustainabledevelopment.un.org/content/documents/2328Global%20Sustainable%20development%20report%202016%20(final).pdf

United Nations. (2018). CONCEPT NOTE High-Level Meeting on "Development cooperation in middle-income countries". retrieved 26 August 2021 from https://www.un.org/pga/73/wp-content/uploads/sites/53/2018/11/HLM-MICS-CONCEPT-NOTE-draft-November-2.pdf

Van Niekerk, A. J. (2020). Inclusive economic sustainability: SDGs and global inequality. *Sustainability*, *12*(13), 5427. https://doi.org/10.3390/su12135427

Van Tulder, R., & Keen, N. (2018). Capturing collaborative challenges: Designing complexity-sensitive theories of change for cross-sector partnerships. *Journal of Business Ethics*, *150*(2), 315–332. https://doi.org/10.1007/s10551-018-3857-7

Van Zanten, J. A., & Van Tulder, R. (2021). Improving companies' impacts on sustainable development: A nexus approach to the SDGS. *Business Strategy and the Environment*, *30*, 3703–3720. https://doi.org/10.1002/bse.2835

Velis, C. A., & Vrancken, K. C. (2015). Which material ownership and responsibility in a circular economy? *Waste Management & Research*, *33*(9), 773–774. https://doi.org/10.1177/0734242X15599305

Vojdani, N., & Lootz, F. (2012). Designing supply chain networks for the offshore wind energy industry. *International Journal of Business Performance and Supply Chain Modelling*, *4*(3–4), 271–284. https://doi.org/10.1504/IJBPSCM.2012.050392

Waheed, B., Khan, F., & Veitch, B. (2009). Linkage-based frameworks for sustainability assessment: Making a case for driving force-pressure-state-exposure-effect-action (DPSEEA) frameworks. *Sustainability*, *1*(3), 441–463. https://doi.org/10.3390/su1030441

Walton, S. V., Handfield, R. B., & Melnyk, S. A. (1998). The green supply chain: Integrating suppliers into environmental management processes. *International Journal of Purchasing and Materials Management*, *34*(1), 2–11. https://doi.org/10.1111/j.1745-493X.1998.tb00042.x

Wan, J., Yi, M., Li, D., Zhang, C., Wang, S., & Zhou, K. (2016). Mobile services for customization manufacturing systems: An example of industry 4.0. *IEEE Access*, *4*, 8977–8986. https://doi.org/10.1109/ACCESS.2016.2631152

Werning, J. P., & Spinler, S. (2020). Transition to circular economy on firm level: Barrier identification and prioritization along the value chain. *Journal of Cleaner Production*, *245*, 118609. https://doi.org/10.1016/j.jclepro.2019.118609

Witjes, S., & Lozano, R. (2016). Towards a more circular economy: Proposing a framework linking sustainable public procurement and sustainable business models. *Resources, Conservation and Recycling*, *112*, 37–44. https://doi.org/10.1016/j.resconrec.2016.04.015

Wolf, G. (2017). New challenges of the digital transformation: the comeback of the vision-mission system. In J. Klewes, D. Popp, & M. Rost-Hein (Eds.), *Out-thinking organizational communications*. Management for Professionals. (pp. 113–128). Springer. https://doi.org/10.1007/978-3-319-41845-2_9

Wright, C. Y., Godfrey, L., Armiento, G., Haywood, L. K., Inglesi-Lotz, R., Lyne, K., & Schwerdtle, P. N. (2019). Circular economy and environmental health in low-and middle-income countries. *Globalization and Health*, *15*, 65. https://doi.org/10.1186/s12992-019-0501-y

Wright, T. S. A. (2002). Definitions and frameworks for environmental sustainability in higher education. *Higher Education Policy*, *15*(2), 105–120. https://doi.org/10.1016/S0952-8733(02)00002-8

Wu, K.-J., Liao, C.-J., Tseng, M., & Chiu, K. K.-S. (2016). Multi-attribute approach to sustainable supply chain management under uncertainty. *Industrial Management and Data Systems*, *116*(4), 777–800. https://doi.org/10.1108/IMDS-08-2015-0327

Wu, L., Yue, X., Jin, A., & Yen, D. C. (2016). Smart supply chain management: A review and implications for future research. *The International Journal of Logistics Management*, *27*(2), 395–417. https://doi.org/10.1108/IJLM-02-2014-0035

Yadav, G., Luthra, S., Jakhar, S. K., Mangla, S. K., & Rai, D. P. (2020). A framework to overcome sustainable supply chain challenges through solution measures of industry 4.0 and circular economy: An automotive case. *Journal of Cleaner Production*, *254*, 120112. https://doi.org/10.1016/j.jclepro.2020.120112

Yu, C., de De Jong, M., & Dijkema, G. P. J. (2014). Process analysis of eco-industrial park development–the case of Tianjin, China. *Journal of Cleaner Production*, *64*, 464–477. https://doi.org/10.1016/j.jclepro.2013.09.002

Zhao, H., Guo, S., & Zhao, H. (2018). Comprehensive benefit evaluation of eco-industrial parks by employing the best-worst method based on circular economy and sustainability. *Environment, Development and Sustainability*, *20*(3), 1229–1253. https://doi.org/10.1007/s10668-017-9936-6

Zhijun, F., & Nailing, Y. (2007). Putting a circular economy into practice in China. *Sustainability Science*, *2*(1), 95–101. https://doi.org/10.1007/s11625-006-0018-1

Zhu, Q., Sarkis, J., & Geng, Y. (2005). Green supply chain management in China: Pressures, practices and performance. *International Journal of Operations & Production Management*, *25*(5), 449–468. https://doi.org/10.1108/01443570510593148

Zouari, D., Ruel, S., & Viale, L. (2021). Does digitalising the supply chain contribute to its resilience? *International Journal of Physical Distribution and Logistics Management*, *51*(2), 149–180. https://doi.org/10.1108/IJPDLM-01-2020-0038

Zsidisin, G. A., & Hendrick, T. E. (1998). Purchasings involvement in environmental issues: A multi-country perspective. *Industrial Management &* *Data Systems*, *98*(7), 313–320. https://doi.org/10.1108/02635579810241773

Zsidisin, G. A., & Siferd, S. P. (2001). Environmental purchasing: A framework for theory development. *European Journal of Purchasing and Supply Management*, *7*(1), 61–73. https://doi.org/10.1016/S0969-7012(00)00007-1