Received: 23 October 2022 | Revised: 30 January 2023 | Accepted: 13 February 2023

DOI: 10.1002/bse.3393

RESEARCH ARTICLE

Business Strategy and the Environment WILEY

Sustainable development-oriented regulatory and competitive pressures to shift toward a circular economy: The role of environmental orientation and Industry 4.0 technologies

Abdullah Kaid Al-Swidi[1] | Joseph F. Hair[2] | Mohammed A. Al-Hakimi[3]

[1]Department of Management and Marketing, College of Business and Economics, Qatar University, Doha, Qatar

[2]Department of Marketing and Quantitative Methods, University of South Alabama, Mobile, Alabama, USA

[3]Department of Marketing and Production, Thamar University, Dhamar, Yemen

Correspondence
Abdullah Kaid Al-Swidi, Department of Management and Marketing, College of Business and Economics, Qatar University, Doha, Qatar.
Email: swidi@qu.edu.qa

Abstract

Automakers' transition from a linear economy to a circular economy (CE) in response to sustainable development-oriented regulatory and competitive pressures is a challenging process that requires innovative, practical technologies. However, Industry 4.0 (I4.0) technologies are an important part of the transition to CE for environmentally friendly companies. In this study, we examine whether regulatory pressure (RP) and competitive pressure (CP) toward sustainability motivate firms to implement I4.0 technologies for CE, along with the mediating effects of environmental orientation (EO). PLS-SEM via SmartPLS software was used to analyze data from 230 managers in the automotive and auto component manufacturing industries in India. The findings of this study showed that RP and CP positively influence I4.0 adoption, which impacts CE capability. Furthermore, EO partially mediates the relationship between RP and CP with I4.0 technologies. As a practical implementation of this study, to transition to CE and contribute to sustainable development, managers need to deal effectively with RP and CP. Several implications for theory and practice are discussed at the end of the study.

KEYWORDS

circular economy, competitive pressures, environmental orientation, Industry 4.0 technologies, regulatory pressures, sustainable development

1 | INTRODUCTION

In the past few years, India has made a commitment to limiting the effects of its economic growth on the natural environment, establishing a "win-win" environmental and economic model, and creating a society that saves resources and is environmentally friendly on the path to transition toward sustainability (Priyadarshini & Abhilash, 2020). The circular economy (CE) is regarded as a key component of sustainable development; the government has enacted a set of rules and regulations targeting industry and society in an effort to adopt a circular industrial system based on the economy (Zeng et al., 2017). On the other hand, firms are also under a lot of pressure from their competitors to adopt environmentally friendly practices (such as CE) (Dai et al., 2014), as is the case for Indian automakers, given the presence of many global auto manufacturers (such as Suzuki, Honda Ford, Toyota, Yamaha, etc.).

CE capability is "the general term implementing the 3R principles (reduction, reuse and recycle) for firms" (Zeng et al., 2017). This capability encompasses a set of interdependent CE practices that work together to accomplish an objective. In the CE, industrial waste is turned into a valuable input that can be fixed, reused, and upcycled using low-cost waste management methods, generating eco-friendly

Abbreviations: α, Cronbach's alpha; AVE, average variance extracted; CCA, confirmatory composite analysis; CB-SEM, covariance-based structural equations modelling; CE, circular economy; CP, competitive pressure; CR, composite reliability; EO, environmental orientation; HTMT, Heterotrait-Monotrait; I4.0, industry 4.0; MAE, Mean absolute error; RBT, Resource-based theory; RMSE, Root mean square error; RP, regulatory pressure; ST, Stakeholders theory; VB-SEM(PLS), variance-based structural equations modelling.

and added-value end products (Singh et al., 2018). The increasing significance of CE is evident in the implementation of numerous initiatives to enhance the CE capability of the firm (Arranz et al., 2022; Haque & Ntim, 2018). However, the shift from a linear economy to CE in response to regulatory and competitive pressures is a challenging process and presents many challenges. The main challenges are "high initial setup costs; supply chain complexity; business-to-business non-cooperation; inadequate information for the design of products and manufacturing process; skill gaps; quality concessions; long lead times for disassembly; and high costs involved in such processes" (Bag & Pretorius, 2022). These challenges can be overcome by adopting Industry 4.0 (I4.0; Chiarini, 2021; Liu et al., 2022; Rusch et al., 2022; Torrent-Sellens et al., 2022). I4.0 can strengthen CE practices by amplifying their positive impacts under a technological context, where manufacturing practices are prioritized over those oriented to the biological cycle, thereby contributing to the SDG related to the biosphere (Dantas et al., 2021).

I4.0, as defined by Bhatia and Kumar (2020: 2441), is "a revolution in manufacturing, which focuses on collaboration between manufacturing and emerging technologies to maximize output with minimum use of resources." I4.0, also seen as a "technological revolution," includes "big data, industrial automation (robotics), simulations, integration systems, additive manufacturing, the internet of things (IoT), cybersecurity, augmented reality, and cloud computing" as fundamental and all-encompassing components of technical activity aimed at continual improvement. I4.0, as a concept, integrates information and communication technologies into manufacturing processes (de Sousa Jabbour, Jabbour, Godinho Filho, & Roubaud, 2018) so that manufacturing is more efficient and adaptable, products are of greater quality, and expenses are reduced (Bhatia & Kumar, 2022). I4.0 technologies enable "interoperability (which can contribute to a reduction in industrial waste and a longer machine life cycle), decentralization (which can contribute to improved utilization of available resources and assets), virtualization (which can reduce industrial waste, increase recycling opportunities, and facilitate the promotion of modern environmental practices), real-time capabilities (which contribute to better adaptation to demand curves, better utilization of resources, and faster response to energy fluctuations), modularity (which leads to better usage of industrial resources, longer machine life cycle), and service orientation (which can improve the usage of final products, increased recycling, and reuse opportunities)" (Bag & Pretorius, 2022). However, numerous researchers have concluded that the research is limited and qualitative and has produced contradicting results; while Bag, Pretorius, et al. (2021) and Bag, Yadav, et al. (2021) found that I4.0 adoption is positively connected with sustainable production, which in turn positively affects CE capabilities, others have found the opposite (e.g., Kiel et al., 2017). Little is known regarding how I4.0 technologies can contribute to building CE capability (e.g., Bag, Pretorius, et al., 2021; Khan et al., 2021; Yu et al., 2022). Therefore, additional research is necessary to draw a conclusion regarding the possible results of I4.0 technologies for enhancing CE performance (Agrawal et al., 2022; Bhatia & Kumar, 2022; Kazancoglu et al., 2021).

The influence of stakeholder pressures on firms' engagement in environmentally friendly practices has been studied using stakeholder theory (ST) (e.g., Al-Swidi et al., 2022; Bhatia & Kumar, 2022; Kayikci et al., 2022). These studies are predicated on the notion that stakeholder pressures (in our case, regulatory and competitive) may have an effect on the environmental activities of firms. Although it is vital to assess the impact of regulatory pressures (RP) and competitive pressures (CP) on how CE models are adopted in the firm, not much is known about how these pressures work (Bhatia & Kumar, 2022). In this regard, research on environmental management has emphasized the significance of environmental orientation (EO) as an emerging ecological stance that contributes to satisfying stakeholder needs while also enhancing environmental performance. EO represents an effective source that provides substantial insight into the perceptions of influential stakeholders in a firm's decision-making processes (Peng & Wei, 2015). EO refers to "the extent to which organizations recognize the importance of environmental issues that they are facing" (Yasir et al., 2020, p. 2). As such, the organizational focus of EO is on meeting the environmental requirements of inner and outer stakeholders, including employees, regulatory authorities, suppliers, consumers, competitors, etc. (Banerjee, 2001). In this study, EO is seen as an important internal component that influences the real response of firms to the growing pressures for sustainability (Chavez et al., 2021; Mady et al., 2022) to adopt I4.0 technologies; thus, it is relevant to investigate whether EO mediates the effect of RP and CP toward sustainability by adopting I4.0 technologies.

Based on an empirical analysis of data from 230 managers in India's automotive industry, our study makes several contributions. First, this study expands the prior literature on the association between stakeholder pressures and I4.0 technologies by examining their implications in the context of the transition toward CE. Second, we investigated the effect of I4.0 technologies adoption on CE capability, which is still unclear in previous studies. In doing so, we respond to a call from Agrawal et al. (2022) to conduct further studies to better understand the nature of the relationship between I4.0 technologies and CE capability. Third, together with external drivers (RP and CP), we explored the role of internal drivers (such as EO) by presenting empirical evidence of the influence of RP and CP for the transition toward CE on the adoption of I4.0 technologies and reporting direct and indirect influences via EO. Fourth, this study focused on automobile industry firms in the context of a developing country such as India when assessing the proposed model. Due to the sustainable advantages of CE, it has been the focus of a lot of studies in many industries, such as the automotive, manufacturing, and service sectors. Recently, few initiatives have been published in the literature on CE, but disappointingly, many developing nations are not making any efforts to adopt CE. In the Indian automotive industry, initiatives linked with CE implementation have not been deeply investigated. Consequently, it is necessary to study possible initiatives to implement CE in developing countries, such as India. Firms from the Indian automobile industry were chosen to participate in this research, since (i) CE has several potential advantages for the automobile industry (Agrawal et al., 2021).

The aim of this paper is to examine the joint effects of RP, CP, and I4.0 technologies on CE implementation by Indian companies. In essence, this study was conducted in India for a number of reasons. First of all, India is one of the most populous countries in the world, with 17% of the global population (Goyal et al., 2018). Global Carbon Project 2021 reports that India was the third largest emitter of carbon dioxide by volume in 2020, after China and the United States. Third, its goal to achieve net zero emissions remains 2070, much later than many other countries have set, and not in line with the Paris Agreement, which sets 2050 as a goal to keep global temperature rises to 1.5C by 2050. Fourth, India produces 62 million tons of solid waste every day, according to statistics. By 2050, this volume is predicted to reach 436 million tons daily. Only 20% of the 62 million tons of solid waste are treated, and the rest is disposed of in landfills (Mallapur, 2014). Specifically, this refers to barriers and challenges related to the infrastructure. Inefficiency in the recycling process, a lack of compatible infrastructure, and unfocused industry-level capabilities hinder awareness, adoption, and growth of the CE. Finally, we will learn about the provision for developing economies from the experience of India.

Despite the vehicle industry's substantial contribution to India's economic growth, it has negative environmental impacts that necessitate the adoption of the CE approach; (ii) the automobile industry has been selected as the primary engine of the "Make in India" program, and according to the "Auto Mission" Plan 2016–2026, the program aims to triple the market for passenger vehicles to 9.4 million units by 2026 (Mathiyazhagan et al., 2018). Thus, we believe that the Indian auto industry is an appropriate context to be investigated from a CE perspective.

2 | THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

2.1 | Underpinning theories

Guided by ST and RBT, we have built a theoretical model that displays the relationships among the study's primary constructs, as shown in Figure 1.

ST has garnered considerable attention in sustainability literature (Al-Swidi et al., 2022; Bhatia & Kumar, 2022). In accordance with Freeman (1984), a stakeholder is "any group or individual who can affect or is affected by the achievement of an organization's objectives." Stakeholders are represented both externally (government, customers, competitors, etc.) and internally (employees, shareholders, etc.) (Bhatia & Kumar, 2022). With stakeholders becoming increasingly concerned about environmental issues, companies face constant pressure from various stakeholder groups to adopt practices that can lead to improved environmental performance (Sarkis et al., 2010). Corporate response to stakeholder demands and cooperation with them leads to a "win-win" situation (King, 2007). Empirical research has examined how stakeholder pressures affect environmental management practices (Betts et al., 2015; Sarkis et al., 2010; Shahzad et al., 2020; Wang et al., 2018; Yu et al., 2017). While RP represents coercive pressure (Agarwal et al., 2018), CP can be noncoercive or normative in nature (Graham, 2020). CP mainly emerges from a firm's perception of the success of its rivals resulting from particular practices (Liu et al., 2010). With competitors adopting environmentally friendly practices, the pressure on other firms in the same market to do so increases (Graham, 2020). Through emulating these practices, a firm tries to decrease risk and gain credibility by following the lead of successful companies or because it does not fully comprehend the requirements for sustained success (Braunscheidel et al., 2011). Using Graham's (2020) insights, we argue that CP toward sustainability can affect firms toward the adoption of I4.0 technologies. Accordingly, our suggested model is based on ST, which posits that organizations must comprehend and respond to RP and CP imposed by stakeholders while implementing environmental protection and competitive advantage strategies. Specifically, we anticipate that RP and CP will have an effect on the adoption of I4.0 technologies that can enhance sustainability performance.

Furthermore, we incorporate RBT as a theoretical foundation to examine how environmentally oriented firms' adoption of I4.0 technologies helps enhance CE capabilities. In accordance with the RBT, an organization acquires and maintains a competitive edge through the development and utilization of valuable resources (Al-Hakimi et al., 2022; Khanra et al., 2022; Wernerfelt, 1984). As such, the

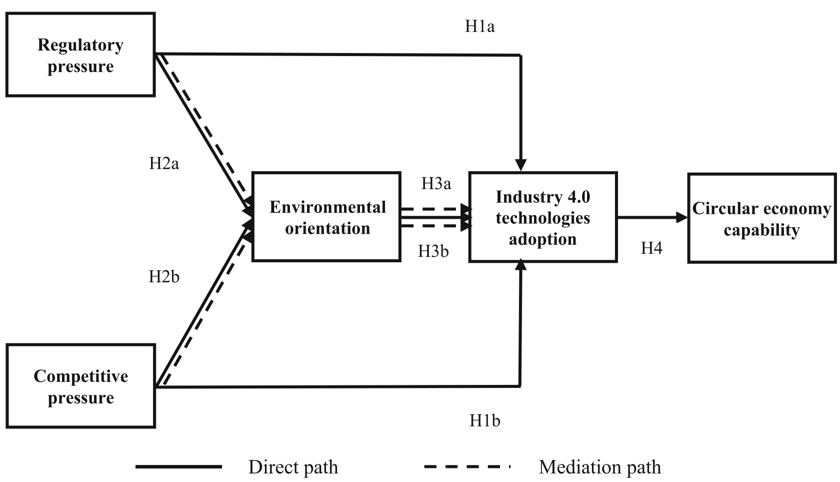

FIGURE 1 Conceptual model.

primary characteristics of the resources are that they are valuable and hard to duplicate (Al-Hakimi, Saleh, & Borade, 2021; Barney, 1991), where the value makes the resources complex and unique. Such resources promote capability building in critical business sectors (e.g., technology, operations, marketing, and distribution), which determine the position of the firm's competitive edge (Bag, Pretorius, et al., 2021). RBT is the most extensively employed theory for exploring the influence of diverse organizational resources on performance outcomes (Wernerfelt, 1984). In the current study, we consider I4.0 technologies as valuable organizational resources (Khan et al., 2022). I4.0 technologies provide organizational value in terms of effective management of resources and operational activities along the assembly line and labor reorganization within the manufacturing system (Braccini & Margherita, 2018; Margherita & Braccini, 2020). In addition to I4.0, various other resources, like ecological awareness and knowledge and EO, can contribute significantly to the enhancement of CE capability and sustainable performance. Consequently, our suggested paradigm integrates both ST and RBT and argues that RP and CP push environment-oriented firms to consider embracing I4.0 technologies in order to boost CE capability in terms of sustainability.

2.2 | CE

Recently, many academics and environmentalists have emphasized CE as a means of attaining sustainable production and consumption. In addition, international organizations like the "World Economic Forum," the "Organization for Economic Cooperation and Development," and the "United Nations Environment Program" are emphasizing the critical importance of closing the material loop (Singhal et al., 2019). In the CE, resources are utilized for longer, and waste is reduced, compared to the linear economy in which products are made, consumed, and discarded (Bag et al., 2019). While some authors (e.g., Pinheiro et al., 2019) have referred to CE as a "closed-loop supply chain" to indicate the integration of sustainability principles in SCM (Ahi & Searcy, 2015), others have used the concept "circular supply chain" to correlate CE with SCM in specific studies (e.g., Mishra et al., 2018; Nasir et al., 2017). However, the existing literature on CE and SCM sustainability is still factionalized, with some major CE concepts expressed at a strategy level and others around SCM functions like design, production, procurement, etc. (Farooque et al., 2019). In this regard, a closed-loop supply chain should not be confused with a circular supply chain, as the scope of value recovery in a "closed-loop" supply chain is often constrained "because the efforts are restricted within the original supply chain (producer's supply chain) and do not include secondary supply chains and/or involve new auxiliary channel members" (Farooque et al., 2019). However, a "circular" supply chain goes further "by recovering value from waste by collaborating with other organizations within the industrial sector (open loop, same sector), or with different industrial sectors (open loop, cross-sector)" (Weetman, 2016).

Overall, remanufacturing is emerging to look like a good option that could help a country in developing a circular business strategy (Hazen et al., 2017). Remanufacturing is common in many industries, such as auto, electrical and electronics, machinery, and furniture, etc. The United States is number one when it comes to making remanufactured products worth $43 billion per year. On either hand, the largest remanufacturers are in Europe, in places like Germany and the United Kingdom (Singhal et al., 2019). However, emerging nations such as India, Brazil, China, Bangladesh, Bhutan, and Sri Lanka have difficulty successfully implementing remanufacturing processes (Govindan et al., 2016). CE is a prevalent approach in many nations; however, its application in India is still in its infancy (Singh et al., 2018), as its practices are confined to repair, refurbishment, reuse, and recycling (Barreiro-Gen & Lozano, 2020). In the context of India, remanufacturing and refurbishing businesses are carried out by just a few firms, such as "Caterpillar, Volvo, General Electric, Hewlett Packard Larsen and Toubro, and Diesel Loco Modernization Works" (Sharma et al., 2016). Remanufacturing is "one of the closed-loop supply chain strategies for a CE, in which end-of-life or end-of-use products are turned into new products by disassembling, cleaning, sorting, refurbishing, or replacing parts, testing, and then putting them back on the market" (Singhal et al., 2019, p. 953). From a sustainability perspective, the remanufacturing strategy offers potential advantages, as remanufactured products involve lower material and energy requirements, produce fewer emissions, and cost less to produce and sell than new products (Wang & Hazen, 2016). Furthermore, remanufacturing gives a chance for firms to engage in pro-environmental practices, such as the conservation of raw materials and the addition of value during product manufacturing.

Numerous studies have addressed the major concerns regarding introducing, developing, and implementing the CE strategy in Indian firms (Khwaja, 2010). According to Singh et al. (2018), lack of funding, inconsistent environmental legislation, and a lack of commitment are the top three obstacles to implementing CE. Similarly, Mutz et al. (2015) concluded that the focus on profit maximization, the lack of political willpower, the failure to share information among agencies, and the lack of coordination across government entities impede progress toward an adequate resource economy. It has been noted that small firms' preparedness for CE is impacted by a number of factors, which include a lack of economic incentives, a scarcity of technical experts, a lack of knowledge about environmental issues, and a failure to implement relevant regulations effectively (Singh et al., 2018).

2.3 | RP and CP and I4.0

According to Alnajem et al. (2021), success in CE adoption requires a huge commitment by all stakeholders to determine the practical implications in the firm, as this may affect productivity and the adoption of required new technology. Consistently, the research identifies regulatory pressures (e.g., government) as the environmental elements that influence the adoption of new technologies (Lin et al., 2018). The past several years have seen many firms invest in the adoption of I4.0 technologies. By implementing I4.0 technologies, firms can contribute to environmental protection and respond to government pressures toward sustainability (Bhatia & Kumar, 2022). For example, the United Nations Industrial Development Organization's (2017) report noted the role of stakeholders, including the government, in adopting I4.0 technologies. RP can play a fundamental role in how I4.0 and other related practices are adopted (Gupta et al., 2020). While Yu and Schweisfurth (2020) found that perceived RP is negatively related to the adoption of I4.0 technologies, Lin et al. (2018) identified government pressures as one of the critical factors for the successful adoption of I4.0 in the Chinese auto industry. Recently, the Indian government has enthusiastically embraced the ideas of I4.0 (Iyer, 2018). India has included "Make in India" in its plan from 2016 to 2026. "Make in India" is an initiative by the government of India to create a manufacturing hub for local and global markets. Recently, many industries have experienced high growth, including "the automotive, electronics, semiconductor, machinery, chemical, pharmaceutical, and aerospace industries" (Mehta & Rajan, 2017). Goswami and Daultani (2021) emphasized in their study that the auto firms and the software firms were at the advanced level of technology readiness in terms of adopting I4.0 technologies. Overall, the literature's findings indicate that there are connections between RP and the strategic response to I4.0.

Furthermore, it is acknowledged that CP is an environmental factor affecting the implementation of new technologies. In a highly competitive sector like the auto industry, firms are compelled to adopt cutting-edge technology either to satisfy customer demand (Kamaruddin & Mohamed Udin, 2009) or to maintain a competitive edge (Lin et al., 2018). In the case of environmental changes, the success of the organization depends on its ability to adapt to those changes and adopt a new management approach (Chang et al., 2002). As an advanced example of contemporary manufacturing, the auto industry is at the forefront of I4.0 implementation in countries with a large manufacturing sector, such as Germany and China (Lin et al., 2018). Meanwhile, India's automotive industry faces a number of obstacles, including unexpected shifts in the global energy system, the rise of novel business models, intense rivalry from foreign automotive brands, a decline in market share, and a low export volume of vehicles. All of these obstacles make it hard to develop and improve India's automotive industry (Van Bruggen et al., 2022). Many studies have provided evidence that businesses consider the environmental practices of their rivals (e.g., Bhatia & Kumar, 2022; Dai et al., 2014). For example, Polonsky (1995) indicated that the pressure generated by the environmental practices of competitors is one of the reasons that drive firms to enhance their environmental practices. Similarly, Bhatia and Kumar (2022) provided empirical evidence supporting the assumption that firms respond to pressures exerted by stakeholders (including competitors) while implementing environmental protection strategies. In particular, they argued that the pressures of stakeholders can affect the adoption of I4 technologies, which in turn can result in outcomes related to sustainability. Related to this, many firms have begun to implement I4.0 technologies in an effort to achieve sustainability (Agarwal et al., 2022). Therefore, if a company does not embrace I4.0 technologies before its rivals, it may not have the ability to achieve the competitive edge and the appropriate level of performance in terms of sustainability (Bhatia & Kumar, 2022). As such, companies are expected to adopt I4.0 technologies in response to CP, which contributes to promoting sustainable performance. Based on the above, we posit that:

H1a. RP positively affects the adoption of I4.0 technologies.

H1b. CP positively affects the adoption of I4.0 technologies.

2.4 | Mediating effect of EO

Recently, the increasing pressures from many stakeholders have forced firms to adopt EO (Acquaah et al., 2021). According to Agyabeng-Mensah et al. (2022), firms' environmental behavior is influenced by external pressure, which also contributes to the efforts toward CE practices (Singh et al., 2018). In the same vein, Govindan et al. (2021) indicate that governments can generate external pressure by formulating rules and regulations that require businesses to incorporate environmentally friendly business practices into their supply chains. Indeed, Baah et al. (2021) assert that RP has recently contributed to the rise in the implementation of environmental sustainability programs in firms. According to Liu et al. (2020), RP, in the form of stringent environmental norms and standards, as well as CP, may have an important influence in the adoption of EO. Earlier, Henriques and Sadorsky (1999) and Sharma and Henriques (2005) indicated that stakeholders exert pressure on firms' environment-related behaviors. According to Schmitz et al. (2019), when RP is high, a firm's orientation shifts from focusing on a proactive environmental strategy to establishing legitimacy within the regulatory framework for stakeholders. Delmas and Toffel (2004) confirmed that stakeholders, including "governments, regulators, competitors, and environmental interest groups," exert normative and coercive pressures on firms. However, firm-specific characteristics, such as their track record of environmental performance, influence how managers understand and respond to these pressures at the level of the firm. In addition, stakeholder pressures may have a significant effect on businesses' environmental initiatives in industrialized nations (Wang et al., 2020). Drawing on ST and prior studies, this study argues that RP and CP drive firms' EO. Accordingly, we assume that:

H2a. RP positively affects a firm's EO.

H2b. CP positively affects a firm's EO.

Besides, firms are warily pursuing to adopt I4.0 technologies. Recently, firms have adopted digital technology to conform to the I4.0 framework (Baden-Fuller & Haefliger, 2013; Gupta et al., 2020). In accordance with Mady et al. (2022), a firm's propensity to adopt I4.0 technologies is correlated with its level of EO. Top management orientation represents one of the firm resources that play an important role in adopting I4.0 technologies toward successful sustainable projects (Bag, Yadav, et al., 2021). According to Torrent-Sellens et al. (2022), I4.0 can be seen as a significant lever for structural change that will further cement the connection between environmentally responsible firm practices and its sustainable performance. To effectively adopt I4.0 technologies, management support to accept changes is paramount in the pursuit of sustainability (Luthra & Mangla, 2018). de Sousa Jabbour, Jabbour, Foropon, and Godinho Filho (2018) suggest that a firm's environmental commitment contributes to the integration of I4.0 technologies and environmentally sustainable practices. In contrast, lack of commitment as a form of resistance to adoption is a major impediment to the effective implementation of I4.0 (Sharma, Kamble, et al., 2021). When business managers recognize the environmental commitment that expresses EO of their firms, they demonstrate a willingness to adopt the necessary resources and capacities to implement sustainable solutions (Chavez et al., 2021). El Baz et al. (2022) emphasize the important role of corporate management orientation in supporting I4.0 initiatives oriented toward sustainability. Gupta et al. (2020) argue that a company's decision to embrace I4.0 technologies is directly related to its exploration and exploitation orientation. Therefore, it is essential to recognize that the intention to embrace I4.0 technologies is also tied to the firm's orientation (Tortorella & Fettermann, 2018). Despite the aforementioned arguments, the mediating role of EO between both RP and CP and I4.0 technologies adoption is not yet clear. Therefore, we propose:

H3a. EO positively mediates the link between RP and the adoption of I4.0 technologies.

H3b. EO positively mediates the link between CP and the adoption of I4.0 technologies.

2.5 | I4.0 technologies and CE capability

I4.0 technologies refer to "a set of technologies that aid the transition from a machine-oriented industry to digitalization" (Kazancoglu et al., 2021, p. 2). The economic benefits of I4.0 technologies include increased product quality, increased production, reduced lead times, more customer satisfaction, and more efficient management of resource flow and allocation. Additionally, the adoption of I4.0 technologies generates many benefits environmentally through improved control over resource usage as a result of more accurate information on resources and energy consumption (Liang et al., 2018). I4.0 technologies also contribute to a reduction in the number of damaged products and product defects, as well as a reduction in waste in general and waste caused by the use of natural resources in manufacturing processes (Herrmann et al., 2014). Moreover, I4.0 technologies aid extend the product lifecycle, hence enhancing the consumption of sustainable products by consumers (Bressanelli et al., 2018). However, it is well recognized that the environmental dimension is at odds with the economic dimension, as ecologically sustainable products and processes are expensive for businesses and customers are typically unwilling to pay more for cleaner products (Margherita & Braccini, 2020). As for the societal benefits of I4.0 technologies, the literature yields conflicting results. The positive results are associated with safer and healthier workplaces (Fatorachian & Kazemi, 2018) and manifest as fewer accidents, enhanced worker morale, and healthier work environments (Braccini & Margherita, 2018). The literature, however, illustrates the negative effects of automation from the perspective of social sustainability, which are in contrast to economic sustainability, in terms of decreasing skills and reducing low- and high-skilled workers when they are replaced by machines (Margherita & Braccini, 2020).

With the I4.0 approach, potential solutions including new technologies and advanced manufacturing can be presented to counteract the risks inherent in switching from the linear economy to CE (Bertassini et al., 2021; Böhmecke-Schwafert et al., 2022). Laskurain-Iturbe et al. (2021) emphasized the importance of I4.0 technologies to radically transition the industry, with the need to monitor this transition from a sustainability standpoint in order to offer solutions to environmental issues in the industry. However, a survey of 85 papers on I4.0 technologies conducted by Kamble et al. (2018) found that only 18% included a sustainability-related approach. Additionally, CE-related research is scarce in the field of I4.0 technologies. One such notable study is that of de Sousa Jabbour, Jabbour, Godinho Filho, and Roubaud (2018). By reviewing the literature, they developed a groundbreaking road map that demonstrates how I4.0 technologies may serve as a foundation for CE practices (Pinheiro et al., 2022). Adopting I4.0 technologies can be helpful for CE-oriented firms by providing more recycling alternatives, thereby extending the life cycle of resources, reducing waste, and helping them quickly adapt to more efficacy operations (Bag, Pretorius, et al., 2021). In accordance with Gupta et al. (2019), I4.0-related technologies adoption has been shown to have a positive link with CE capability, which is backed by a few studies (e.g., Bag, Pretorius, et al., 2021; Khan et al., 2022; Massaro et al., 2021). Advanced I4.0 technologies can enhance CE adoption by opening up the resource cycle in the system (Di Maria et al., 2022). The I4.0 framework has been determined to be a powerful enabler capable of integrating I4.0 technologies and CE capability (Bag, Pretorius, et al., 2021; Rajput & Singh, 2019). Nascimento et al. (2019) concluded that I4.0 technologies, including big data and artificial intelligence improve CE capability. Although there is a wide assumption of the positive role of I4.0 technologies in boosting the CE capability of firms (Lacy & Rutqvist, 2015), the reverse may also occur. For instance, digital technologies "like robotics, 3D printing, and augmented reality" may make it harder to implement environmental initiatives as a result of the conflict between economic results (i.e., customization and flexibility) with sustainability. Additionally, there may be potential trade-offs in the digitalization–CE relationship (Di Maria et al., 2022). In fact, digitalization may boost resource efficiency, but in return, it may increase energy consumption and waste emissions (Chen et al., 2020; Di Maria et al., 2022). Based on the above, we assume that:

H4. The adoption of I4.0 technologies positively affects CE capability.

3 | METHODOLOGY

3.1 | Sample and data collection

To test the hypotheses in the proposed model shown in Figure 1, a survey-based approach was employed with primary data gathered from auto manufacturing firms in India. The companies were selected from the "Society of Indian Automotive Manufacturers" and the "Automotive Components Manufacturers Association of India" databases. Overall, 400 firms were contacted to fill out the survey. Participation in the survey was voluntary and limited to respondents with at least 2 years of experience in the automobile industry, so as to guarantee a minimum level of familiarity among respondents with knowledge of the automotive industry. In addition, the survey was limited to respondents familiar with the I4.0 and CE concepts, as the authors provided a brief about I4.0 and CE at the beginning of the survey tool. In the end, 230 respondents filled out the whole questionnaire with an overall response rate of 57.5%, considered acceptable (Malhotra & Grover, 1998). Following these procedures, it took 5 months (February to June 2022) to collect the data. This study's respondents varied in terms of gender, position, age, and work experience (see Table 1). In addition, the studied firms varied in the characteristics of size (100–500 employees: 48.26%, 501–1000 employees: 33.91%, and above 1000 employees: 17.83%) and age (less than 20 years: 14.35% and 20 years and above: 85.65%).

3.2 | Measurement

In this work, we used a survey questionnaire tool to collect the data needed to assess the proposed model's relationships. The scales of this study were developed depending on prior relevant studies as well as in-depth interviews with nine academics and business professionals to ensure that all items are appropriate to measure the identified variables. On the basis of the received feedback, the wording of some items was revised to ensure clarity and ease of understanding for respondents (Dillman, 2000) and to represent the nature of the business environment. Appendix A contains a list of the constructs and items utilized to measure them.

To ensure construct validity and reliability, all constructs and indicators were derived from prior research and adapted to fit the context of this study. A five-item measure of CE capability was adapted from Bag, Pretorius, et al. (2021). With regard to independent variables, a three-item measure of RP was adapted from Baah et al. (2021), and a four-item measure of CP was adapted from Bhatia and Kumar (2022). Regarding EO, it was measured by a six-item scale adapted from Gabler et al. (2015), and finally, a four-item measure of I4.0 was adapted from Bhatia and Kumar (2022).

3.3 | Common method bias (CMB)

As the first step after data collection, we performed a common method bias (CMB) test before using the collected data for further statistical analysis. CMB is "a common issue in statistical-based investigations when the data is collected from a single respondent from a firm, which may lead to an artificial increase in sample sizes and inflated estimates" (Podsakoff & Organ, 1986). CMB was minimized by making sure the measurement items were easy to understand, keeping the respondent's identity secret, and only asking respondents who know what I4.0 and CE are (Podsakoff et al., 2003). Nonetheless, we conducted "Harman's one-factor" test to determine whether or not CMB was present, following the procedures of Podsakoff et al. (2012). They proposed performing a preliminary factor analysis on all questions contained in the questionnaire. A high effect of error variance can be taken into account if one factor stands out from the analysis and/or if the first factor explains more than 50% of the variance. Previous research suggested that Harman's method may not find CMB compared to other tests; however, recent research indicates that it is a very useful method (Fuller et al., 2016). Our research revealed that the factor accounts for 45.6% of the overall variance, showing that CMB is not an issue for the data in this study.

4 | DATA ANALYSIS AND RESULTS

To test the relatively complicated model of the study, we employed PLS-SEM via SmartPLS 3 software, according to the guidelines of Ringle et al. (2005, 2015). Numerous benefits of PLS-SEM have led to its widespread use in management and related social sciences studies (Al-Hakimi, Saleh, & Borade, 2021; Al-Swidi et al., 2021). It is the suitable method when dealing with smaller sample sizes (Henseler

TABLE 1 Simple's profile.

Category	Frequency (%)	Category	Frequency (%)
Gender		Position	
Male	202(87.83%)	Factory manager	14(6.09%)
Female	28(12.17%)	Manufacturing/production manager	177(76.95%)
Experience		Technology and digitization manager	39(16.96%)
1–5 years	25(10.87%)	Age	
6–10 years	39(16.96%)	Less than 40 years	44(19.13%)
11–15 years	109(47.39%)	41–50 years	169(73.48%)
Above 15 years	57(24.78%)	Above 50 years	17(7.39%)

et al., 2009) and when prediction is the primary focus of the research (Hair et al., 2022). When applied to complex models with small sample sizes, it has more statistical power than covariance-based SEM (Hair et al., 2022).

However, several researchers have recently raised some doubts about the supposed misapplication of PLS-SEM as it relates to model arguments in favor of PLS-SEM: "small sample sizes, large model complexity, less restrictive distributional assumptions, less restrictive use of formative measurement models" (Sharma, Kamble, et al., 2021). For example, Evermann and Rönkkö (2021) have made several questionable claims, the most notable of which is that PLS is a well-known bias estimator—a property often referred to as the PLS-SEM bias. Even though this characteristic is heavily emphasized in the CB-SEM versus PLS-SEM debate, simulation experiments demonstrate that the disparities between the two estimations are very small (Reinartz et al., 2009). Thus, the extensively researched PLS-SEM bias rarely has a significant impact on the outcomes of practical applications due to the fact that estimates will be asymptotically accurate under consistent large-scale assumptions (i.e., large numbers of indicators per latent variable and a large sample size) (Jöreskog & Wold, 1982).

Moreover, despite the fact that PLS-SEM yields biased estimates on average, they display a lower degree of variability in comparison to the estimates that are generated by CB-SEM (Reinartz et al., 2009; Ringle et al., 2012). This is particularly useful for research circumstances in which CB-SEM based on maximum probability generally exhibits inflated standard errors (Sharma, Thomas, & Paul, 2021; Sosik et al., 2009) and the method's assumptions are broken (e.g., high model complexity, small sample size, non-normal data). This increased efficiency of parameter estimation is demonstrated by the greater statistical power of PLS-SEM compared to CB-SEM. This fits in well with the present analysis, given PLS-SEM's ability to analyze relationships between several constructs simultaneously, in which the sample consists of 230 cases. The PLS model consists of two interdependent models: the "measurement model" and the "structural model".

4.1 | Measurement model

In this study, the measurement model was assessed following the confirmatory composite analysis (CCA) approach (Hair et al., 2020). The reliability is obtained when the values of Cronbach's alpha (α) and composite reliability (CR) exceed 0.70 (Nunnally & Bernstein, 1994). In addition, the construct validity was evaluated by "convergent validity" and "discriminant validity" (Hair, Risher, et al., 2019; Hair, Sarstedt, & Ringle, 2019). The average variance extracted (AVE) value for each construct must exceed 0.50 (Hair et al., 2011; Sarstedt

TABLE 2 Loadings, reliability, and convergent validity.

Constructs	Items code	Factor loading	CR(α)	AVE	Convergent validity
RP	RP1	0.893	0.950 (0.921)	0.864	Yes
	RP2	0.958			
	RP3	0.937			
CP	CP1	0.902	0.963 (0.949)	0.867	Yes
	CP2	0.945			
	CP3	0.936			
	CP4	0.940			
EO	EO1	0.923	0.977 (0.971)	0.875	Yes
	EO2	0.942			
	EO3	0.948			
	EO4	0.913			
	EO5	0.938			
	EO6	0.949			
I4.0	I41	0.919	0.893 (0.830)	0.684	Yes
	I42	0.543			
	I43	0.916			
	I44	0.871			
CE	CEC1	0.874	0.953 (0.939)	0.803	Yes
	CEC2	0.903			
	CEC3	0.923			
	CEC4	0.864			
	CEC5	0.916			

Abbreviations: AVE, average variance extracted; CE, circular economy; CP, competitive pressure; CR, composite reliability; EO, environmental orientation; I4.0, Industry 4.0; RP, regulatory pressure; α, Cronbach's alpha.

et al., 2022) to validate convergent validity. Furthermore, the factor loadings for each item must exceed a minimum of 0.50 (Hair et al., 2018).

Besides, the "heterotrait–monotrait (HTMT)" method was performed to validate discriminant validity (Henseler et al., 2015). According to Kline (2011), the values in the HTMT matrix should not exceed 0.90, particularly between the constructs, in which the results of our study were not excessed that cutoff as illustrated in Table 3. As illustrated in Tables 2 and 3, all requirements (i.e., loadings, reliability, and validity) were met, indicating the measurement models are valid.

Overall, the results demonstrate the model's constructs (see Figure 1) exhibit convergent and discriminant validity.

TABLE 3 Discriminant validity.

Constructs	RP	CP	EO	I4.0	CE
RP					
CP	0.231				
EO	0.247	0.306			
I4.0	0.835	0.341	0.463		
CE	0.250	0.279	0.606	0.520	

TABLE 4 Regression analysis results.

Direct paths	β	*t* value	*p* value	Decision
RP → I4.0	0.634	7.831	0.000	*Supported*
CP → I4.0	0.087	2.361	0.019	*Supported*
RP → EO	0.178	2.743	0.006	*Supported*
CP → EO	0.258	4.179	0.000	*Supported*
EO → I4.0	0.284	4.443	0.000	*Supported*
I4.0 → CE	0.511	6.593	0.000	*Supported*

4.2 | Structural model

The structural model was evaluated following the second step guidelines of the CCA process (Hair et al., 2020). The significance of the model's paths (Figure 1) was evaluated with t-statistic computed via a bootstrapping technique (Peng & Lai, 2012; Sarstedt et al., 2022). As a follow-up, control variables (e.g., firm size and age) were evaluated based on our review of previous research (Manley et al., 2021). Results revealed there were no statistically significant effects of the control variables on the EO, I4.0, and CE variables.

Table 4 summarizes the findings of the hypotheses. The findings indicate all paths were positive and significant. Therefore, H1a, H1b, H2a, H2b, and H4 are supported.

Furthermore, the indirect analysis was conducted to examine whether EO mediates the relationship of RP and CP with I4.0 following the guidelines of Sarstedt et al. (2020). The results summarized in Table 5 confirm that EO partially mediates the RP–I4.0 relationship and also the CP–I4.0 relationship. Thus, H3a and H3b are supported.

Following that, we assessed the study model's explanatory power using the explained variance (R^2) of the endogenous constructs. As illustrated in Table 6, the R^2 values of the endogenous constructs of our model were EO (0.118), I4.0 (0.612), and CE (0.261). The results can be assessed using Chin's guidelines for prediction (0.10 = weak; 0.33 = moderate; 0.67 = large) (Chin, 1998).

Furthermore, we utilized Cohen's f^2 guidelines to assess the effect size of each predictor (Cohen, 2013). The f^2 values of 0.35, 0.15, and 0.02, according to Cohen (2013), have been categorized as "large," "medium," and "small," respectively. Accordingly, the effect size of RP on EO was 0.034, RP on I4.0 was 0.955, CP on EO was 0.072, CP on I4.0 was 0.017, EO on I4.0 was 0.183, and I4.0 on CE capability was 0.354 (see Table 6). Additionally, the model's capability to predict was evaluated using Stone–Geisser's (Q^2). The Q^2 of the endogenous constructs are EO (0.101), I4.0 (0.399), and CE capability (0.199), respectively, which are above zero, showing adequate predictive relevance (Hair et al., 2022; Peng & Lai, 2012).

TABLE 5 Mediation analysis results.

	Indirect path			Direct path			
Mediation paths	β	*t* value	*p* value	β	*t* value	*p* value	Decision
RP → EO → I4.0	0.050	2.228	0.026	0.634	7.831	0.000	*Partial mediation*
CP → EO → I4.0	0.073	2.787	0.006	0.087	2.361	0.019	*Partial mediation*

TABLE 6 R^2, prediction, and effect size.

			f^2 in relation to		
Constructs	R^2	Q^2	EO	I4.0 technologies	CE capability
RP			0.034	0.955	
CP			0.072	0.017	
EO	0.118	0.101		0.183	
I4.0	0.612	0.399			0.354
CE	0.261	0.199			

TABLE 7 PLSpredict assessment.

		PLS		LM	
Indicators	Q^2	RMSE	MAE	RMSE	MAE
EO1	0.085	0.085	0.638	0.653	0.535
EO2	0.107	0.107	0.586	0.599	0.501
EO3	0.072	0.072	0.581	0.597	0.508
EO4	0.069	0.069	0.615	0.630	0.528
EO5	0.108	0.108	0.564	0.577	0.491
EO6	0.087	0.087	0.566	0.581	0.494
I41	0.539	0.539	0.416	0.419	0.279
I42	0.027	0.027	0.615	0.616	0.518
I43	0.528	0.528	0.414	0.424	0.284
I44	0.477	0.477	0.482	0.489	0.308
CE1	0.055	0.596	0.498	0.599	0.500
CE2	0.028	0.611	0.507	0.614	0.512
CE3	0.055	0.612	0.505	0.618	0.510
CE4	0.068	0.599	0.511	0.611	0.516
CE5	0.021	0.646	0.538	0.646	0.541

As a final assessment of the predictive capabilities of the structural model, the PLSpredict procedure was performed to evaluate the prediction errors (Manley et al., 2021; Shmueli et al., 2019). The process provided Q^2 and a comparison of the RMSE and LM predictions errors. Table 7 displays the Q^2 values that were determined by comparing the prediction errors of PLS findings to simple mean predictions. All values of Q^2 were greater than zero, indicating that the prediction error of the PLS findings was lower than the prediction error brought on by relying just on the mean values. Furthermore, the variations in results between PLS and LM (referred to as PLS-LM differences) were relatively minor for the majority of indicators, including "mean absolute error (MAE)" and "root-mean-square error (RMSE)." According to the guidelines of Hair, Risher, et al. (2019), the model has medium predictive power when a minority of indicators in the PLS-SEM analysis produce larger prediction errors relative to the LM criterion. Thus, the predictive validity of the model was confirmed.

5 | DISCUSSION

Depending on ST and RBT, the present study investigates the direct and indirect effects of RP and CP on the adoption of I4.0 technologies through EO, as well as examines the effect of the adoption of I4.0 technologies on CE capability. By conducting a survey of companies in the automotive industry in India, this study makes an empirical investigation of the model and the assumptions built and presents the following conclusions.

The findings suggest that RP and CP positively and significantly affect the adoption of I4.0 technologies. This relates to the study by Gupta et al. (2020), which indicated that RP could play a pivotal role in adopting I4.0 and associated technologies. This differs from the results of Yu and Schweisfurth (2020) who found that perceived RP is negatively connected with the adoption of I4.0 technologies, as well as results from Bhatia and Kumar (2022) who concluded that CP is not correlated with the adoption of I4. 0 techniques.

Our results also suggest that both RP and CP have a significant and positive effect on EO. This argument is first in line with the early study of Henriques and Sadorsky (1999), who found that environmentally conscious managers considered all stakeholders important, with the exception of the media, and second, with the results presented by Sharma and Henriques (2005), who found that groups of stakeholders can put indirect pressure on organizations by using more powerful stakeholders to do so.

Moreover, our findings indicate that for Indian automotive industry firms, RP and CP can facilitate the adoption of I4.0 technologies directly and indirectly through EO, which reveals the internal mechanism of external pressures to adopt I4.0 technologies within firms. Furthermore, our results demonstrate that Indian automotive industry firms that adopt I4.0 technologies have better capabilities when practicing CE. This result is backed up by previous research (e.g., Bag, Pretorius, et al., 2021; Gupta et al., 2019; Yu et al., 2022).

5.1 | Implications for theory

Theoretically, this research adds to what is known by shedding fresh light on the interrelationships between RP, CP, EO, I4.0, and CE. First, prior research has utilized ST to assess the impact of stakeholder pressure on I4.0 technologies and other environmental management practices (e.g., Bhatia & Kumar, 2022). Research such as this has shown stakeholder pressures to be an important antecedent for adopting I4.0 technologies. This study extended this knowledge in the context of the transition toward CE. The results demonstrate that RP and CP have an important role, especially in developing countries, like India in terms of I4.0 technologies adoption and sustainability practices, such as CE.

Second, our study examined the link between the adoption of I4.0 technologies and CE capability. The important finding here was that the adoption of I4.0 technologies had a significant positive effect on CE capability. This contributes to an understanding of the discrepancy in the findings of previous work (Di Maria et al., 2022).

Third, the results showed that another factor that had a strong impact on our theoretical model is EO. Along with external drivers (RP and CP), internal drivers (EO) can affect the actual response of firms to handle the increasing pressures toward sustainability and act as a mediator in the relationship of both RP and CP to firms' adoption of I4.0 technologies. The RBT framework provides a compelling explanation for this mechanism. EO can urge firms to undertake environmental practices in response to sustainability concerns and pressures (Mady et al., 2022). The indirect effect demonstrates that businesses do explore adopting I4.0 technologies in response to external pressures. As such, top management orientation is critical (Dai et al., 2014), and research has highlighted it as a crucial "internal organizational resource" for environmental management (e.g., Bhatia &

Kumar, 2022). This finding suggests that managers and other corporate leaders should assess the extent to which their stakeholders value I4.0 technologies and act accordingly. This means that firms will not engage with RP and CP unless they realize the potential advantages of I4.0 technologies. This research sheds light on the RP and CP and resources necessary for the implementation of I4.0 in Indian automobile manufacturing firms.

Finally, although the relationship between I4.0 technologies and CE capability has been studied and analyzed at an early stage, it is still an open issue for discussion by researchers and professionals from different fields. Consequently, the current study presents theoretical and empirical evidence from manufacturing firms, especially those firms that make up the automotive industry of a developing country, such as India, which is considered one of the most important industries for the country's economic growth.

5.2 | Implications for practice

In practice, this research has important implications. First, our study suggests that understanding the role of RP and CP can help support firms' orientation to embrace I4.0 technologies and shift toward CE. I4.0 technologies adoption can offer advantages to Indian automotive manufacturing firms engaged in CE by increasing recycling possibilities, extending the life cycle of materials, reducing waste, and rapidly adapting to more efficient processes.

Second, for Indian automotive industry firms, the focus of them should be on adopting EO. According to the study findings, EO plays a mediating role in the relationship between RP and CP and the adoption of I4.0 technologies. Therefore, managers are recommended to not only enhance EO but also to diffuse environmental culture among firm employees. It is essential for businesses to advance EO by defining their environmental missions and incorporating environmental concerns into their corporate strategy and operational procedures, which contributes to the development of effective EO. When a firm faces pressure from the stakeholders toward achieving sustainability, it has no choice but to adopt EO to remain in business, and then, it should adopt I4.0 technologies. Just as RP and CP drive environmentally oriented firms to improve their performance (Baah et al., 2021), we find that environmentally oriented firms tend to adopt the technology resources needed in enhancing their environmental capabilities and ultimately achieve sustainability. The transition from a linear economy to a CE is a challenging goal; EO may lead Indian automotive industry firms toward the transition to CE; however, this mechanism can be more appropriate when firms prioritize the adoption of I4.0 technologies.

6 | LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

Despite the abovementioned promising findings, our study includes some limitation from its methodology, its sample, and its characteristics, as do all empirical studies. First, we focused solely on firms in the Indian automobile sector in our analysis. Even if the Indian market is one of the largest global industries, the social environment in which the automotive sector operates in India is unlike any other nation. Second, future researchers should consider longitudinal data to further investigate the measurement and structural model relationships. Case-based studies may also be helpful in providing further evidence that supports the conclusions of this study. Third, the automobile industry was examined in an emerging market, India. Although I4.0 and CE are relatively new in India, this industry is one of the most prominent industries practicing them. Therefore, future research could test this model in other industries, developed countries, or across countries. Finally, while our study addressed I4.0 technologies in general, we neglected to consider the effects of specific technologies; therefore, future studies can investigate the effects of different I4.0 technologies to find out which technologies are most important in enhancing CE capability.

ACKNOWLEDGMENTS

No funding to be acknowledged and the work in this research is conducted by only the listed authors.

CONFLICT OF INTEREST

There is no conflict of interest for all the authors.

ORCID

Abdullah Kaid Al-Swidi https://orcid.org/0000-0002-1718-0269
Mohammed A. Al-Hakimi https://orcid.org/0000-0001-9923-1439

REFERENCES

Acquaah, M., Agyapong, A., & Aidoo, S. (2021). Environmental orientation, green supply chain management, and institutional pressures on performance. *Academy of Management Proceedings*, *2021*(1), 11660. https://doi.org/10.5465/AMBPP.2021.11660abstract

Agarwal, A., Giraud-Carrier, F. C., & Li, Y. (2018). A mediation model of green supply chain management adoption: The role of internal impetus. *International Journal of Production Economics*, *205*, 342–358. https://doi.org/10.1016/j.ijpe.2018.09.011

Agarwal, V., Hameed, A. Z., Malhotra, S., Mathiyazhagan, K., Alathur, S., & Appolloni, A. (2022). Role of industry 4.0 in agile manufacturing to achieve sustainable development. *Business Strategy and the Environment*, 1–18. https://doi.org/10.1002/bse.3321

Agrawal, R., Wankhede, V. A., Kumar, A., & Luthra, S. (2021). Analysing the roadblocks of circular economy adoption in the automobile sector: Reducing waste and environmental perspectives. *Business Strategy and the Environment*, *30*(2), 1051–1066. https://doi.org/10.1002/bse.2669

Agrawal, R., Wankhede, V. A., Kumar, A., Luthra, S., & Huisingh, D. (2022). Progress and trends in integrating industry 4.0 within circular economy: A comprehensive literature review and future research propositions. *Business Strategy and the Environment*, *31*(1), 559–579. https://doi.org/10.1002/bse.2910

Agyabeng-Mensah, Y., Afum, E., Baah, C., & Essel, D. (2022). Exploring the role of external pressure, environmental sustainability commitment, engagement, alliance and circular supply chain capability in circular economy performance. *International Journal of Physical Distribution and Logistics Management*, *52*(5/6), 431–455. https://doi.org/10.1108/IJPDLM-12-2021-0514

Ahi, P., & Searcy, C. (2015). An analysis of metrics used to measure performance in green and sustainable supply chains. *Journal of Cleaner Production*, *86*, 360–377. https://doi.org/10.1016/j.jclepro.2014.08.005

Al-Hakimi, M. A., Saleh, M. H., & Borade, D. B. (2021). Entrepreneurial orientation and supply chain resilience of manufacturing SMEs in Yemen: The mediating effects of absorptive capacity and innovation. *Heliyon*, *7*(10), e08145. https://doi.org/10.1016/j.heliyon.2021.e08145

Al-Hakimi, M. A., Saleh, M. H., Borade, D. B., Hasan, M. B., & Sharma, D. (2022). Competitor orientation and SME performance in competitive environments: The moderating effect of marketing ethics. *Journal of Entrepreneurship in Emerging Economies*, ahead-of-print, 1–22. https://doi.org/10.1108/JEEE-12-2021-0486

Alnajem, M., Mostafa, M. M., & ElMelegy, A. R. (2021). Mapping the first decade of circular economy research: A bibliometric network analysis. *Journal of Industrial and Production Engineering*, *38*(1), 29–50. https://doi.org/10.1080/21681015.2020.1838632

Al-Swidi, A. K., Al-Hakimi, M. A., Gelaidan, H. M., & Al-Temimi, S. K. A. (2022). How does consumer pressure affect green innovation of manufacturing SMEs in the presence of green human resource management and green values? A moderated mediation analysis. *Business Ethics, the Environment & Responsibility*, *31*, 1157–1173. https://doi.org/10.1111/beer.12459

Al-Swidi, A. K., Gelaidan, H. M., & Saleh, R. M. (2021). The joint impact of green human resource management, leadership and organizational culture on employees' green behaviour and organisational environmental performance. *Journal of Cleaner Production*, *316*, 1, 128112–12. https://doi.org/10.1016/j.jclepro.2021.128112

Arranz, C. F., Sena, V., & Kwong, C. (2022). Institutional pressures as drivers of circular economy in firms: A machine learning approach. *Journal of Cleaner Production*, *355*, 1–13. https://doi.org/10.1016/j.jclepro.2022.131738

Baah, C., Opoku-Agyeman, D., Acquah, I. S. K., Agyabeng-Mensah, Y., Afum, E., Faibil, D., & Abdoulaye, F. A. M. (2021). Examining the correlations between stakeholder pressures, green production practices, firm reputation, environmental and financial performance: Evidence from manufacturing SMEs. *Sustainable Production and Consumption*, *27*, 100–114. https://doi.org/10.1016/j.spc.2020.10.015

Baden-Fuller, C., & Haefliger, S. (2013). Business models and technological innovation. *Long Range Planning*, *46*(6), 419–426. https://doi.org/10.1016/j.lrp.2013.08.023

Bag, S., Gupta, S., & Foropon, C. (2019). Examining the role of dynamic remanufacturing capability on supply chain resilience in circular economy. *Management Decision*, *57*(4), 863–885. https://doi.org/10.1108/MD-07-2018-0724

Bag, S., & Pretorius, J. H. C. (2022). Relationships between industry 4.0, sustainable manufacturing and circular economy: Proposal of a research framework. *International Journal of Organizational Analysis*, *30*(4), 864–898. https://doi.org/10.1108/IJOA-04-2020-2120

Bag, S., Pretorius, J. H. C., Gupta, S., & Dwivedi, Y. K. (2021). Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices and circular economy capabilities. *Technological Forecasting and Social Change*, *163*, 120420. https://doi.org/10.1016/j.techfore.2020.120420

Bag, S., Yadav, G., Dhamija, P., & Kataria, K. K. (2021). Key resources for industry 4.0 adoption and its effect on sustainable production and circular economy: An empirical study. *Journal of Cleaner Production*, *281*, 125233. https://doi.org/10.1016/j.jclepro.2020.125233

Banerjee, S. B. (2001). Managerial perceptions of corporate environmentalism: Interpretations from industry and strategic implications for organizations. *Journal of Management Studies*, *38*(4), 489–513. https://doi.org/10.1111/1467-6486.00246

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Barreiro-Gen, M., & Lozano, R. (2020). How circular is the circular economy? Analysing the implementation of circular economy in organisations. *Business Strategy and the Environment*, *29*(8), 3484–3494. https://doi.org/10.1002/bse.2590

Bertassini, A. C., Ometto, A. R., Severengiz, S., & Gerolamo, M. C. (2021). Circular economy and sustainability: The role of organizational behaviour in the transition journey. *Business Strategy and the Environment*, *30*(7), 3160–3193. https://doi.org/10.1002/bse.2796

Betts, T. K., Wiengarten, F., & Tadisina, S. K. (2015). Exploring the impact of stakeholder pressure on environmental management strategies at the plant level: What does industry have to do with it? *Journal of Cleaner Production*, *92*, 282–294. https://doi.org/10.1016/j.jclepro.2015.01.002

Bhatia, M. S., & Kumar, S. (2020). Critical success factors of industry 4.0 in automotive manufacturing industry. *IEEE Transactions on Engineering Management*, *69*(5), 2439–2453. https://doi.org/10.1109/TEM.2020.3017004

Bhatia, M. S., & Kumar, S. (2022). Linking stakeholder and competitive pressure to industry 4.0 and performance: Mediating effect of environmental commitment and green process innovation. *Business Strategy and the Environment*, *31*(5), 1905–1918. https://doi.org/10.1002/bse.2989

Böhmecke-Schwafert, M., Wehinger, M., & Teigland, R. (2022). Blockchain for the circular economy: Theorizing blockchain's role in the transition to a circular economy through an empirical investigation. *Business Strategy and the Environment*, *31*, 3786–3801. https://doi.org/10.1002/bse.3032

Braccini, A. M., & Margherita, E. G. (2018). Exploring organizational sustainability of industry 4.0 under the triple bottom line: The case of a manufacturing company. *Sustainability*, *11*(1), 1–17. https://doi.org/10.3390/su11010036

Braunscheidel, M. J., Hamister, J. W., Suresh, N. C., & Star, H. (2011). An institutional theory perspective on six sigma adoption. *International Journal of Operations & Production Management*, *31*(4), 423–451. https://doi.org/10.1108/01443571111119542

Bressanelli, G., Adrodegari, F., Perona, M., & Saccani, N. (2018). The role of digital technologies to overcome circular economy challenges in PSS business models: An exploratory case study. *Procedia Cirp*, *73*, 216–221. https://doi.org/10.1016/j.procir.2018.03.322

Chang, S. C., Lin, N. P., Wea, C. L., & Sheu, C. (2002). Aligning manufacturing capabilities with business strategy: An empirical study in high-tech industry. *International Journal of Technology Management*, *24*(1), 70–87. https://doi.org/10.1504/IJTM.2002.003045

Chavez, R., Malik, M., Ghaderi, H., & Yu, W. (2021). Environmental orientation, external environmental information exchange and environmental performance: Examining mediation and moderation effects. *International Journal of Production Economics*, *240*, 108222. https://doi.org/10.1016/j.ijpe.2021.108222

Chen, X., Despeisse, M., & Johansson, B. (2020). Environmental sustainability of digitalization in manufacturing: A review. *Sustainability*, *12*(24), 1–31. https://doi.org/10.3390/su122410298

Chiarini, A. (2021). Industry 4.0 technologies in the manufacturing sector: Are we sure they are all relevant for environmental performance? *Business Strategy and the Environment*, *30*(7), 3194–3207. https://doi.org/10.1002/bse.2797

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. In *Modern methods for business research* (pp. 295–336). Psychology Press.

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Routledge. https://doi.org/10.4324/9780203771587

Dai, J., Montabon, F. L., & Cantor, D. E. (2014). Linking rival and stakeholder pressure to green supply management: Mediating role of top management support. *Transportation Research Part E: Logistics and Transportation Review*, *71*, 173–187. https://doi.org/10.1016/j.tre.2014.09.002

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

de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Foropon, C., & Godinho Filho, M. (2018). When titans meet–can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting and Social Change*, *132*, 18–25. https://doi.org/10.1016/j.techfore.2018.01.017

de Sousa Jabbour, A. B. L., 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

Delmas, M., & Toffel, M. W. (2004). Stakeholders and environmental management practices: An institutional framework. *Business Strategy and the Environment*, *13*(4), 209–222. https://doi.org/10.1002/bse.409

Di Maria, E., De Marchi, V., & Galeazzo, A. (2022). Industry 4.0 technologies and circular economy: The mediating role of supply chain integration. *Business Strategy and the Environment*, *31*(2), 619–632. https://doi.org/10.1002/bse.2940

Dillman, D. A. (2000). Procedures for conducting government-sponsored establishment surveys: Comparisons of the total design method (TDM), a traditional cost-compensation model, and tailored design. In Proceedings of American statistical association, second international conference on establishment surveys (pp. 343-352).

El Baz, J., Tiwari, S., Akenroye, T., Cherrafi, A., & Derrouiche, R. (2022). A framework of sustainability drivers and externalities for industry 4.0 technologies using the best-worst method. *Journal of Cleaner Production*, *344*, 130909. https://doi.org/10.1016/j.jclepro.2022.130909

Evermann, J., & Rönkkö, M. (2021). Recent developments in PLS. *Communications of the Association for Information Systems*, *44*, 123–132.

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

Fatorachian, H., & Kazemi, H. (2018). A critical investigation of industry 4.0 in manufacturing: Theoretical operationalisation framework. *Production Planning and Control*, *29*(8), 633–644. https://doi.org/10.1080/09537287.2018.1424960

Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Pitman Publisher.

Fuller, C., Dickerson, M., Atinc, G., Atinc, Y., & Babin, B. (2016). Common method variance detection in business research. *Journal of Business Research*, *69*(8), 3192–3198. https://doi.org/10.1016/j.jbusres.2015.12.008

Gabler, C. B., Richey, R. G. Jr., & Rapp, A. (2015). Developing an eco-capability through environmental orientation and organizational innovativeness. *Industrial Marketing Management*, *45*, 151–161. https://doi.org/10.1016/j.indmarman.2015.02.014

Goswami, M., & Daultani, Y. (2021). Make-in-India and industry 4.0: Technology readiness of select firms, barriers and socio-technical implications. *The TQM Journal*, *34*, 1485–1505. https://doi.org/10.1108/TQM-06-2021-0179

Govindan, K., Shankar, K. M., & Kannan, D. (2016). Application of fuzzy analytic network process for barrier evaluation in automotive parts remanufacturing towards cleaner production–a study in an Indian scenario. *Journal of Cleaner Production*, *114*, 199–213. https://doi.org/10.1016/j.jclepro.2015.06.092

Govindan, K., Shaw, M., & Majumdar, A. (2021). Social sustainability tensions in multi-tier supply chain: A systematic literature review towards conceptual framework development. *Journal of Cleaner Production*, *279*, 1–22. https://doi.org/10.1016/j.jclepro.2020.123075

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

Graham, S. (2020). The influence of external and internal stakeholder pressures on the implementation of upstream environmental supply chain practices. *Business & Society*, *59*(2), 351–383. https://doi.org/10.1177/0007650317745636

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

Gupta, S., Modgil, S., Gunasekaran, A., & Bag, S. (2020). Dynamic capabilities and institutional theories for industry 4.0 and digital supply chain. *Supply Chain Forum: An International Journal*, *21*(3), 139–157. https://doi.org/10.1080/16258312.2020.1757369

Hair, J., Risher, J., Sarstedt, M., & Ringle, C. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2018). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hair, J. F., Howard, M., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of Business Research*, *109*, 101–110. https://doi.org/10.1016/j.jbusres.2019.11.069

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–151. https://doi.org/10.2753/MTP1069-6679190202

Hair, J. F., Sarstedt, M., & Ringle, C. M. (2019). Rethinking some of the rethinking of partial least squares. *European Journal of Marketing*, *53*(4), 566–584. https://doi.org/10.1108/EJM-10-2018-0665

Haque, F., & Ntim, C. G. (2018). Environmental policy, sustainable development, governance mechanisms and environmental performance. *Business Strategy and the Environment*, *27*(3), 415–435. https://doi.org/10.1002/bse.2007

Hazen, B. T., Mollenkopf, D. A., & Wang, Y. (2017). Remanufacturing for the circular economy: An examination of consumer switching behavior. *Business Strategy and the Environment*, *26*(4), 451–464. https://doi.org/10.1002/bse.1929

Henriques, I., & Sadorsky, P. (1999). The relationship between environmental commitment and managerial perceptions of stakeholder importance. *Academy of Management Journal*, *42*(1), 87–99. https://doi.org/10.5465/256876

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In R. R. Sinkovics & P. N. Ghauri (Eds.), *New challenges to international marketing (advances in international marketing, Vol. 20)* (pp. 277–319). Emerald Group Publishing Limited. https://doi.org/10.1108/S1474-7979(2009)0000020014

Herrmann, C., Schmidt, C., Kurle, D., Blume, S., & Thiede, S. (2014). Sustainability in manufacturing and factories of the future. *International Journal of Precision Engineering and Manufacturing-Green Technology*, *1*(4), 283–292. https://doi.org/10.1007/s40684-014-0034-z

Iyer, A. (2018). Moving from industry 2.0 to industry 4.0: A case study from India on leapfrogging in smart manufacturing. *Procedia Manufacturing*, *21*, 663–670. https://doi.org/10.1016/j.promfg.2018.02.169

Jöreskog, K. G., & Wold, H. (1982). The ML and PLS techniques for modeling with latent variables: Historical and comparative aspects. In K. G. Jöreskog & H. Wold (Eds.), *Systems under indirect observation, part I* (pp. 263–270). North-Holland.

Kamaruddin, N. K., & Mohamed Udin, Z. (2009). Supply chain technology adoption in Malaysian automotive suppliers. *Journal of Manufacturing Technology Management*, *20*(3), 385–403. https://doi.org/10.1108/17410380910936819

Kamble, S. S., Gunasekaran, A., & Gawankar, S. A. (2018). Sustainable industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. *Process Safety and Environmental Protection*, *117*, 408–425. https://doi.org/10.1016/j.psep.2018.05.009

Kayikci, Y., Kazancoglu, Y., Gozacan-Chase, N., & Lafci, C. (2022). Analyzing the drivers of smart sustainable circular supply chain for sustainable development goals through stakeholder theory. *Business Strategy and the Environment*, *31*(7), 3335–3353. https://doi.org/10.1002/bse.3087

Kazancoglu, Y., Ozkan-Ozen, Y. D., Sagnak, M., Kazancoglu, I., & Dora, M. (2021). Framework for a sustainable supply chain to overcome risks in transition to a circular economy through industry 4.0. *Production Planning and Control*, ahead of print, 1–16. https://doi.org/10.1080/09537287.2021.1980910

Khan, S. A. R., Razzaq, A., Yu, Z., & Miller, S. (2021). Industry 4.0 and circular economy practices: A new era business strategies for environmental sustainability. *Business Strategy and the Environment*, *30*(8), 4001–4014. https://doi.org/10.1002/bse.2853

Khan, S. A. R., Umar, M., Asadov, A., Tanveer, M., & Yu, Z. (2022). Technological revolution and circular economy practices: A mechanism of green economy. *Sustainability*, *14*(8), 4524. https://doi.org/10.3390/su14084524

Khanra, S., Kaur, P., Joseph, R. P., Malik, A., & Dhir, A. (2022). A resource-based view of green innovation as a strategic firm resource: Present status and future directions. *Business Strategy and the Environment*, *31*(4), 1395–1413. https://doi.org/10.1002/bse.2961

Khwaja, R. H. (2010). Report of the committee to evolve road map on management of wastes in India. Ministry of Environment and Forest (MoEF), India. Retrieved August 2, 2022 from: http://www.moef.nic.in/sites/default/files/Roadmap-Mgmt-Waste.pdf

Kiel, D., Arnold, C., & Voigt, K. I. (2017). The influence of the industrial internet of things on business models of established manufacturing companies–A business level perspective. *Technovation*, *68*, 4–19. https://doi.org/10.1016/j.technovation.2017.09.003

King, A. (2007). Cooperation between corporations and environmental groups: A transaction cost perspective. *Academy of Management Review*, *32*(3), 889–900. https://doi.org/10.5465/amr.2007.25275680

Kline, R. B. (2011). Convergence of structural equation modeling and multilevel modeling. In *The SAGE handbook of innovation in social research methods*. SAGE. https://doi.org/10.4135/9781446268261.n31

Lacy, P., & Rutqvist, J. (2015). *Waste to wealth: The circular economy advantage* (pp. 3–18). Palgrave Macmillan.

Laskurain-Iturbe, I., Arana-Landín, G., Landeta-Manzano, B., & Uriarte-Gallastegi, N. (2021). Exploring the influence of industry 4.0 technologies on the circular economy. *Journal of Cleaner Production*, *321*, 1–14. https://doi.org/10.1016/j.jclepro.2021.128944

Liang, Y. C., Lu, X., Li, W. D., & Wang, S. (2018). Cyber physical system and big data enabled energy efficient machining optimisation. *Journal of Cleaner Production*, *187*, 46–62. https://doi.org/10.1016/j.jclepro.2018.03.149

Lin, D., Lee, C. K. M., Lau, H., & Yang, Y. (2018). Strategic response to industry 4.0: An empirical investigation on the Chinese automotive industry. *Industrial Management & Data Systems*, *118*(3), 589–605. https://doi.org/10.1108/IMDS-09-2017-0403

Liu, H., Ke, W., Wei, K. K., Gu, J., & Chen, H. (2010). The role of institutional pressures and organizational culture in the firm's intention to adopt internet-enabled supply chain management systems. *Journal of Operations Management*, *28*(5), 372–384. https://doi.org/10.1016/j.jom.2009.11.010

Liu, Q., Trevisan, A. H., Yang, M., & Mascarenhas, J. (2022). A framework of digital technologies for the circular economy: Digital functions and mechanisms. *Business Strategy and the Environment*, *31*(5), 2171–2192. https://doi.org/10.1002/bse.3015

Liu, S., Eweje, G., He, Q., & Lin, Z. (2020). Turning motivation into action: A strategic orientation model for green supply chain management. *Business Strategy and the Environment*, *29*(7), 2908–2918. https://doi.org/10.1002/bse.2580

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

Mady, K., Abdul Halim, M. A. S., Omar, K., Abdelkareem, R. S., & Battour, M. (2022). Institutional pressure and eco-innovation: The mediating role of green absorptive capacity and strategically environmental orientation among manufacturing SMEs in Egypt. *Cogent Business & Management*, *9*(1), 1–24. https://doi.org/10.1080/23311975.2022.2064259

Malhotra, M. K., & Grover, V. (1998). An assessment of survey research in POM: From constructs to theory. *Journal of Operations Management*, *16*(4), 407–425. https://doi.org/10.1016/S0272-6963(98)00021-7

Mallapur, C. (2014) Million truckloads daily: India's real trash problem. Retrieved October, 16, 2016.

Manley, S. C., Hair, J. F., Williams, R. I., & McDowell, W. C. (2021). Essential new PLS-SEM analysis methods for your entrepreneurship analytical toolbox. *International Entrepreneurship and Management Journal*, *17*(1), 1–21. https://doi.org/10.1007/s11365-020-00687-6

Margherita, E. G., & Braccini, A. M. (2020). Industry 4.0 technologies in flexible manufacturing for sustainable organizational value: Reflections from a multiple case study of Italian manufacturers. *Information Systems Frontiers*, 1–22. https://doi.org/10.1007/s10796-020-10047-y

Massaro, M., Secinaro, S., Dal Mas, F., Brescia, V., & Calandra, D. (2021). Industry 4.0 and circular economy: An exploratory analysis of academic and practitioners' perspectives. *Business Strategy and the Environment*, *30*(2), 1213–1231. https://doi.org/10.1002/bse.2680

Mathiyazhagan, K., Sengupta, S., & Poovazhagan, L. (2018). A decision making trial and evaluation laboratory approach to analyse the challenges to environmentally sustainable manufacturing in Indian automobile industry. *Sustainable Production and Consumption*, *16*, 58–67. https://doi.org/10.1016/j.spc.2018.05.007

Mehta, Y., & Rajan, A. J. (2017). Manufacturing sectors in India: Outlook and challenges. *Procedia Engineering*, *174*, 90–104. https://doi.org/10.1016/j.proeng.2017.01.173

Mishra, J. L., Hopkinson, P. G., & Tidridge, G. (2018). Value creation from circular economy-led closed loop supply chains: A case study of fast-moving consumer goods. *Production Planning and Control*, *29*(6), 509–521. https://doi.org/10.1080/09537287.2018.1449245

Mutz, D., Roy, M., Boiral, O., & Paillé, P. (2015). Circular economy and informal waste management in India-A contradiction? Institute of Development Studies, Resource Politics. Retrieved August 7, 2022.

Nascimento, D. L. M., Alencastro, V., Quelhas, O. L. G., Caiado, R. G. G., Garza-Reyes, J. A., Rocha-Lona, L., & Tortorella, G. (2019). Exploring industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal. *Journal of Manufacturing Technology Management*, *30*(3), 607–627. https://doi.org/10.1108/JMTM-03-2018-0071

Nasir, M. H. A., Genovese, A., Acquaye, A. A., Koh, S. C. L., & Yamoah, F. (2017). Comparing linear and circular supply chains: A case study from the construction industry. *International Journal of Production Economics*, *183*, 443–457. https://doi.org/10.1016/j.ijpe.2016.06.008

Nunnally, J. C., & Bernstein, I. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill Education.

Peng, D. X., & Lai, F. (2012). Using partial least squares in operations management research: A practical guideline and summary of past research.

Journal of Operations Management, *30*(6), 467–480. https://doi.org/10.1016/j.jom.2012.06.002

Peng, X. R., & Wei, J. (2015). Stakeholders' environmental orientation and eco-innovation: The moderating role of top managers' environmental awareness. *Studies in Science of Science*, *33*(7), 1109–1120.

Pinheiro, M. A. P., Jugend, D., de Sousa, L., Jabbour, A. B., Chiappetta Jabbour, C. J., & Latan, H. (2022). Circular economy-based new products and company performance: The role of stakeholders and industry 4.0 technologies. *Business Strategy and the Environment*, *31*(1), 483–499. https://doi.org/10.1002/bse.2905

Pinheiro, M. A. P., Seles, B. M. R. P., De Camargo Fiorini, P., Jugend, D., de Sousa, L., Jabbour, A. B., da Silva, H. M. R., & Latan, H. (2019). The role of new product development in underpinning the circular economy: A systematic review and integrative framework. *Management Decision*, *57*(4), 840–862. https://doi.org/10.1108/MD-07-2018-0782

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, *63*(1), 539–569. https://doi.org/10.1146/annurev-psych-120710-100452

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management*, *12*(4), 531–544. https://doi.org/10.1177/014920638601200408

Polonsky, M. J. (1995). A stakeholder theory approach to designing environmental marketing strategy. *Journal of Business & Industrial Marketing*, *10*(3), 29–46. https://doi.org/10.1108/08858629510096201

Priyadarshini, P., & Abhilash, P. C. (2020). Circular economy practices within energy and waste management sectors of India: A meta-analysis. *Bioresource Technology*, *304*, 1, 123018–34. https://doi.org/10.1016/j.biortech.2020.123018

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

Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of Research in Marketing*, *26*(4), 332–344. https://doi.org/10.1016/j.ijresmar.2009.08.001

Ringle, C. M., Sarstedt, M., & Straub, D. W. (2012). A critical look at the use of PLS-SEM in MIS quarterly. *MIS Quarterly*, *36*(1), 3–14.

Ringle, C. M., Wende, S., & Becker, J. M. (2015). SmartPLS 3 Boenningstedt: SmartPLS GmbH, 584.

Ringle, C. M., Wende, S., & Will, A. (2005). SmartPLS 2.0 (Beta). Retrieved July 3, 2022, from: www.smartpls.de

Rusch, M., Schöggl, J. P., & Baumgartner, R. J. (2022). Application of digital technologies for sustainable product management in a circular economy: A review. *Business Strategy and the Environment*, 1–16. https://doi.org/10.1002/bse.3099

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

Sarstedt, M., Hair, J. F. Jr., Nitzl, C., Ringle, C. M., & Howard, M. C. (2020). Beyond a tandem analysis of SEM and PROCESS: Use of PLS-SEM for mediation analyses! *International Journal of Market Research*, *62*(3), 288–299. https://doi.org/10.1177/1470785320915686

Sarstedt, M., Hair, J. F. Jr., & Ringle, C. M. (2022). "PLS-SEM: Indeed a silver bullet"–retrospective observations and recent advances. *Journal of Marketing Theory and Practice*, 1–15. https://doi.org/10.1080/10696679.2022.2056488

Schmitz, E. A., Baum, M., Huett, P., & Kabst, R. (2019). The contextual role of regulatory stakeholder pressure in proactive environmental strategies: An empirical test of competing theoretical perspectives. *Organization & Environment*, *32*(3), 281–308. https://doi.org/10.1177/1086026617745992

Shahzad, M., Qu, Y., Zafar, A. U., Ding, X., & Rehman, S. U. (2020). Translating stakeholders' pressure into environmental practices–the mediating role of knowledge management. *Journal of Cleaner Production*, *275*, 1–11. https://doi.org/10.1016/j.jclepro.2020.124163

Sharma, G. D., Thomas, A., & Paul, J. (2021). Reviving tourism industry post-COVID-19: A resilience-based framework. *Tourism Management Perspectives*, *37*, 100786.

Sharma, M., Kamble, S., Mani, V., Sehrawat, R., Belhadi, A., & Sharma, V. (2021). Industry 4.0 adoption for sustainability in multi-tier manufacturing supply chain in emerging economies. *Journal of Cleaner Production*, *281*, 1, 125013–54. https://doi.org/10.1016/j.jclepro.2020.125013

Sharma, S., & Henriques, I. (2005). Stakeholder influences on sustainability practices in the Canadian forest products industry. *Strategic Management Journal*, *26*(2), 159–180. https://doi.org/10.1002/smj.439

Sharma, V., Garg, S. K., & Sharma, P. B. (2016). Identification of major drivers and roadblocks for remanufacturing in India. *Journal of Cleaner Production*, *112*, 1882–1892. https://doi.org/10.1016/j.jclepro.2014.11.082

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLS predict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Singh, M. P., Chakraborty, A., & Roy, M. (2018). Developing an extended theory of planned behavior model to explore circular economy readiness in manufacturing MSMEs, India. *Resources, Conservation and Recycling*, *135*, 313–322. https://doi.org/10.1016/j.resconrec.2017.07.015

Singhal, D., Tripathy, S., & Jena, S. K. (2019). Acceptance of remanufactured products in the circular economy: An empirical study in India. *Management Decision*, *57*(4), 953–970. https://doi.org/10.1108/MD-06-2018-0686

Sosik, J. J., Kahai, S. S., & Piovoso, M. J. (2009). Silver bullet or voodoo statistics? A primer for using the partial least squares data analytic technique in group and organization research. *Group & Organization Management*, *34*(1), 5–36. https://doi.org/10.1177/1059601108329198

Torrent-Sellens, J., Ficapal-Cusí, P., & Enache-Zegheru, M. (2022). Boosting environmental management: The mediating role of industry 4.0 between environmental assets and economic and social firm performance. *Business Strategy and the Environment*, *32*, 753–768. https://doi.org/10.1002/bse.3173

Tortorella, G. L., & Fettermann, D. (2018). Implementation of industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, *56*(8), 2975–2987. https://doi.org/10.1080/00207543.2017.1391420

United Nations Industrial Development Organization. (2017). Accelerating clean energy through Industry 4.0: manufacturing the next revolution. Nagasawa, T., Pillay, C., Beier, G., Fritzsche, K., Pougel, F., Takama, T., The, K., Bobashev, I. A report of the United Nations Industrial Development Organization, Vienna, Austria. Retrieved on July 2, 2022 from: https://www.unido.org/sites/default/files/2017-08/REPORT_Accelerating_clean_energy_through_Industry_4.0.Final_0.pdf

Van Bruggen, A. R., Zonneveld, M., Zijp, M. C., & Posthuma, L. (2022). Solution-focused sustainability assessments for the transition to the circular economy: The case of plastics in the automotive industry. *Journal of Cleaner Production*, *358*, 1–12. https://doi.org/10.1016/j.jclepro.2022.131606

Wang, L., Li, W., & Qi, L. (2020). Stakeholder pressures and corporate environmental strategies: A meta-analysis. *Sustainability*, *12*(3), 1172. https://doi.org/10.3390/su12031172

Wang, S., Li, J., & Zhao, D. (2018). Institutional pressures and environmental management practices: The moderating effects of environmental commitment and resource availability. *Business Strategy and the Environment*, *27*(1), 52–69. https://doi.org/10.1002/bse.1983

Wang, Y., & Hazen, B. T. (2016). Consumer product knowledge and intention to purchase remanufactured products. *International Journal of*

Production Economics, 181, 460–469. https://doi.org/10.1016/j.ijpe.2015.08.031

Weetman, C. (2016). *A circular economy handbook for business and supply chains: Repair, remake, redesign, rethink*. Kogan Page Publishers.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180. https://doi.org/10.1002/smj.4250050207

Yasir, M., Majid, A., & Qudratullah, H. (2020). Promoting environmental performance in manufacturing industry of developing countries through environmental orientation and green business strategies. *Journal of Cleaner Production*, *275*, 123003. https://doi.org/10.1016/j.jclepro.2020.123003

Yu, F., & Schweisfurth, T. (2020). Industry 4.0 technology implementation in SMEs–A survey in the Danish-German border region. *International Journal of Innovation Studies*, *4*(3), 76–84. https://doi.org/10.1016/j.ijis.2020.05.001

Yu, J., Lo, C. W. H., & Li, P. H. Y. (2017). Organizational visibility, stakeholder environmental pressure and corporate environmental responsiveness in China. *Business Strategy and the Environment*, *26*(3), 371–384. https://doi.org/10.1002/bse.1923

Yu, Z., Khan, S. A. R., & Umar, M. (2022). Circular economy practices and industry 4.0 technologies: A strategic move of automobile industry. *Business Strategy and the Environment*, *31*(3), 796–809. https://doi.org/10.1002/bse.2918

Zeng, H., Chen, X., Xiao, X., & Zhou, Z. (2017). Institutional pressures, sustainable supply chain management, and circular economy capability: Empirical evidence from Chinese eco-industrial park firms. *Journal of Cleaner Production*, *155*, 54–65. https://doi.org/10.1016/j.jclepro.2016.10.093

How to cite this article: Al-Swidi, A. K., Hair, J. F., & Al-Hakimi, M. A. (2023). Sustainable development-oriented regulatory and competitive pressures to shift toward a circular economy: The role of environmental orientation and Industry 4.0 technologies. *Business Strategy and the Environment*, *32*(7), 4782–4797. https://doi.org/10.1002/bse.3393

APPENDIX A

Questionnaire items

Regulatory pressure: (1 = *not important* to 5 = *very important*)
RP1. Government
RP2. Trade associations and unions
RP3. Media
Competitive pressure: (1 = *strongly disagree* to 5 = *strongly agree*)
CP1. Sustainability initiatives have been widely implemented by our competitors
CP2. Our competitors who have implemented sustainability initiatives benefitted greatly
CP3. Our competitors who have implemented sustainability initiatives are perceived favorably by their customers
CP4. Our competitors who have implemented sustainability initiatives became more competitive
Environmental orientation: (1 = *strongly disagree* to 5 = *strongly agree*)
EO1. Our firm has a clear policy statement urging environmental awareness
EO2. Environmental preservation is a high priority in our firm
EO3. Preserving the environment is a central value in our firm
EO4. Our firm promotes environmental preservation as a major corporate goal
EO5. Our firm has a responsibility to preserve the environment
EO6. Our firm strives for an image of environmental responsibility
Industry 4.0 technologies: (1 = *not considering* to 5 = *adopting successfully*)
I41. Additive manufacturing
I42. Cyber physical systems
I43. Big data analytics
I44. Internet of Things
Circular economy capability: (1 = *strongly disagree* to 5 = *strongly agree*)
CE1. Our firm is dedicated to reducing the unit product manual input
CE2. Our firm is dedicated to reducing the consumption of raw materials and energy
CE3. Our firm initiatively enhances the energy efficiency of production equipment
CE4. In our firm, the leftover material is used repeatedly to manufacture other products
CE5. In our firm, waste produced in the manufacturing process is recycled