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Benchmarking electric power companies' sustainability and circular economy behaviors: using a hybrid PLS-SEM and MCDM approach

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Abstract
This research examines the impact of firms' decision-making, crisis management, and risk-taking behaviors on their sustainability and circular economy behaviors through the mediating role of their eco-innovation behavior in the energy industry in Iraq. Firms are exploring applicable mechanisms to increase green practices. This requires the industry to possess the essential skills to overcome the challenges that reduce sustainable activities. We applied a dual-stage structural equation modeling (PLS-SEM) and a multi-criteria decision-making (MCDM) approach to explore the linear relationships between variables, determine the weight of the criteria, and rank energy companies based on a circular economy. The online questionnaire was sent to 549 managers and heads of departments of Iraqi electric power companies. Out of these, 384 questionnaires were collected. The results indicate that firms' crisis management, decision-making, and risk-taking behaviors are significantly and positively linked to their eco-innovation behavior. This study confirms the significant and positive impact of firms' eco-innovation behavior on their sustainability and circular economy behaviors. Likewise, eco-innovation behavior has a fully mediating role. For the MCDM methods, ranking energy companies according to the circular economy can support policymakers' decisions to renew contracts with leading companies in the ranking. Practitioners can also impose government regulations on low-ranked companies. Thus, governments can reduce the problems of greenhouse gas emissions and other environmental pollution.

Keywords Eco-innovation · Circular economy · Crisis management · Decision-making · Risk-taking · Sustainability

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1 Introduction

Electricity companies are the primary cause and contributor to environmental pollution and greenhouse gas emissions (Rosales-Calderon and Arantes,2019). Consequently, the world's rapid economic growth at the expense of severe environmental pollution has made the energy sector the largest emitter of greenhouse gases and energy consumers in the world (Li et al., 2019; Shi et al., 2019; Yang et al., 2019). Environmental pollution from the energy sector significantly impacts human prosperity and health because resource consumption and environmental pollution limit sustainable development and threaten human health (Chen et al., 2018; Li et al., 2019). Global competition's continual change and quick technical progress are critical characteristics of economies (Abdul Latif et al., 2021; Hansen et al., 2018). The quickly changing environment has increased the challenges for businesses to adjust to external opportunities (Mannan et al., 2018). Several firms attempt to shift these threats to new, more sustainable business models (Chen et al., 2017). Energy companies strive to create a sustainable industry by mitigating hazardous emissions and consuming fewer natural resources (Singh et al., 2019). Since the circular economy and eco-innovation contribute to reducing climate change, decreasing greenhouse gas emissions, and mitigating air pollution, exploring these issues is hotspot research. Hence, eco-innovation is crucial to organizational prosperity by confirming long-term survival and global competitiveness (Alnoor, 2020). Eco-innovation depends on human, financial, and natural resources. In this context, eco-innovation contributes to increasing the added value of products and services by generating modern and beneficial ideas (Abdullah et al., 2022a; Carrillo-Hermosilla et al., 2010; Sadaa et al., 2022).

Numerous countries have enacted regulations to promote sustainable industrialization, including limits on industry emissions and incentives for renewable energy (Meng et al., 2018). Several governments and industries have adopted the sustainability approach to address environmental issues and conserve energy (Brunke et al., 2014). However, previous literature has explored determinants that limit sustainability and circular economy activities. Previous studies have emphasized the critical influence of risk management factors such as decision-making, risk-taking, and crisis management on eco-innovation, sustainability, and circular economy (Carvalho & Sugano 2016; Dahlander et al., 2021; Sánchez & Aznar, 2015). Hence, decision-making and risk-taking contribute to developing sustainability and a circular economy (Adams et al., 2016; Zink & Geyer, 2019). Besides, decision-making and risk-taking play vital roles in enhancing eco-innovation by encouraging knowledge acquisition, adaptation of new technology, and increasing opportunities for exploration and exploitation of environmentally friendly products in the energy sector (Ali et al., 2020; De Jesus & Mendonça, 2018; Scott-Ladd & Chan, 2004). Despite that, the decline in the quality of decisions, the weakness of taking risks, and the failure to deal with crises wisely generate huge risks of environmental pollution and greenhouse gases (Coulthard et al., 2019).

Nearly 80% of global energy consumption is still provided by fossil fuels (Paladugula et al., 2018). Policymakers must seriously deal with environmental pollution by increasing the activities and applications of sustainable development and environmental innovation for energy use and consumption (Santoyo-Castelazo & Azapagic, 2014). Thus, sustainability contributes to the development of the energy system and environmental innovation and increases the chances of acceptance and adoption of renewable energy technologies (Kumar et al., 2017). Moreover, incorporating sustainability in energy consumption and eco-innovation management boosts energy efficiency and reduces waste in the energy industry (Mangla et al., 2020). Concern about the influence of energy sources on society and the environment has prompted an urgent need to investigate energy sustainability and environmental innovation in the energy industry (Chaudhary & Kumar, 2021). Various research has concentrated on many sustainable energy production strategies in the energy industry to offset the harmful impacts of pollutants produced from their power generation operations. Mangla et al. (2020) considered reusing other renewable energy sources to lessen environmental issues and make the best energy use. Attempts were continued by previous literature. Hence, hybrid MCDM methods and SWOT analysis were used to determine the best alternative energy strategies and plans (Almutairi et al., 2022). In addition to evaluating renewable and conventional energy sources for the energy sector to determine the best energy option (Ighravwe et al., 2022). Furthermore, gas, thermal, nuclear, wind, solar, hydro energy, and biomass options are used as alternatives in the decision model (Saraswat & Digalwar, 2021). Previous literature has also used MCDM in the energy sector to assess the economic and environmental performance of energy in Organization for Economic Co-operation and Development countries (Gökgöz & Yalçın, 2021).

The health harm to individuals and the environment caused by greenhouse gases and burning fossil fuels has motivated scientists to explore solar energy sources to enhance power generation systems. MCDM methods have been utilized to give insights into the selection and ranking of energy sector organizations based on sustainability and eco-innovation aspects (Saraswat & Digalwar, 2021). Scientists and academics have also thoroughly investigated the sustainability practices of energy sector corporations. Several studies have investigated electrical sustainability techniques in the energy industry by applying MCDM approaches. To our knowledge, determining the best energy companies based on a circular economy has rarely been reported in previous studies, especially since international reports and previous research confirm that Iraq is one of the major oil and energy exporters (Alnoor, 2020; Ishfaq et al., 2018).

The energy industry is experiencing rising demands in terms of social, economic, and environmental performance. Identifying the best sustainable companies in the field of electric power generation based on clean energy sources supports and enhances the image and reputation of the energy sector companies (Wang et al., 2019). Determining the best and worst companies is a complex process that needs to be resolved due to several variables and the different importance of the variables. Therefore, the MCDM approach deals with complex problems (Alsalem et al., 2021). However, there are few pieces of information to distinguish the best and worst firms in the sustainable energy sector. Recognizing the best sustainable firms in the energy sector can assist in improving legitimacy, and transparency, boost the brand value and raise the firm reputation (Alnoor et al., 2022a, b, c; Bouncken & Tiberius 2021). The identification and evaluation of the environmentally sustainable energy industry have regularly gained the attention of academics and policymakers for identifying the best sustainable company in the energy industry. We raise the important question: What are the critical criteria that determine leading sustainable firms in the energy sector? Therefore, this study developed a novel conceptual framework to enhance business models by performing the SEM analysis to identify the circular economy's determinants. Hence, we used MCDM methods to conduct benchmarking among firms in the energy sector.

To this end, this study overcomes the gap in previous studies by examining the impact of firms' crisis management, risk-taking, and decision-making behaviors on their sustainability and circular economy behaviors through the mediating role of their eco-innovation behavior in the energy sector in Iraq by adopting a dual stage of SEM and MCDM. In summary, this study aims to explain the impact of firms' crisis management, risk-taking, and decision-making behaviors on their sustainability behavior through their eco-innovation behaviors. To reach this goal, we use the PLS-SEM approach and adopt the MCDM methods of weighing and ranking to assign a weight, determine the importance of variables, and rank the firms in the energy sector accordingly.

2 Literature review

2.1 Eco-innovation

Eco-innovation is the superior use of resources to reduce negative environmental impacts and create new products that benefit businesses (Carrillo-Hermosilla et al., 2010). Eco-innovation can be described as a set of innovations that mitigate negative environmental impacts. Eco-innovation includes developing new or improved products with environmentally friendly materials, designs, and processes that reduce resource consumption and pollution, mitigate environmental damage, and marketing solutions that promote pro-environmental behaviors (Ramkumar et al., 2022). Eco-innovation is represented as the development, integration, or adoption of new products resulting in reduced excess pollution and negative impacts (Kesidou & Demirel, 2012; Karakaya et al., 2014). Many companies are committed to sustainable development by creating serious attempts to adopt and implement environmental innovation (Halila & Rundquist, 2011). As a result, governments pursue support for eco-innovation for environmental and economic sustainability. Many countries are enhanced to create a new consciousness, the institutionalization of eco-innovation, and interest in improving environmentally friendly goods and services (Kiefer et al., 2017). There is considerable growth in the interest of industries in eco-innovation to achieve superior and sustainable performance (Horbach, 2014). Eco-innovations seek to improve the environmental efficiency of existing products and processes. Eco-innovation improves the quality of life for societies through environmental management systems, material use, energy use, and water use (Kemp & Pearson, 2007; Hellström, 2007). Increased adoption and diffusion of eco-innovations by companies can be critical to reducing the environmental impact and providing products, services, and practices that promote environmentally sustainable consumption (Bossle et al., 2016). Eco-innovations are critical in bringing about incremental and radical improvements to improve the quality of life (Rennings, 2000; Tiberius et al., 2021b).

Moreover, companies implementing eco-innovations generate positive environmental externalities that benefit society in the long term (Hojnik & Ruzzier, 2016; Jaffe et al., 2005). Circular economy and sustainability are becoming increasingly important to governments, investors, businesses, and the public. Sustainability envisions the harmonious combination of social inclusion, environmental resilience, and economic performance to benefit present and future generations (Geissdoerfer et al., 2017). Enhanced circular economy and sustainability necessitate innovation in firms' value creation, understanding, and business practices. Companies are required to collaborate with the eco-innovation of actors. Therefore, innovation in circular economy and sustainability is a crucial competency for businesses (Pieroni et al., 2019).

2.2 Circular economy/closed-loop economy

Energy is a massive industry; energy production accounts for 70% of all greenhouse gas emissions worldwide (Alnoor et al., 2022a, b, c). The circular economy is a new industrial and economic concept that provides a combined practice that concentrates on corporate ideas and thoughts with products and systems with the significant target of environmental, social, and economic advantage by improving and conserving resources (Kravchenko et al.,2019). A circular economy is an economic system that aims to effectively use resources through closed loops of products, long-term value retention, waste minimization, and reduction of primary resources, product parts, and materials. A circular economy is a sustainable system that reduces resources, waste, and energy inputs by narrowing the material and energy chain (Geissdoerfer et al., 2017; Camilleri, 2020). The circular economy aims to generate wealth, jobs, cost savings, and environmental, economic, and social benefits by adopting key concepts of reuse, recycling, and recovery (Koumparou, 2017). The circular economy was previously associated with requirements to reduce, reuse, and recycle, which are essential components of the waste management mechanism. The literature has expanded the concept of circular economy to include new elements represented in redesign, refurbishment, and reuse (Reike et al., 2018). Four new series have been added to the concept of a circular economy rethink, repair, remanufacture, and recover (Morseletto, 2020: Manickam & Duraisamy, 2019). As a result, governments should develop regulations that incentivize companies to use efficient waste management practices based on elements of a circular economy (Kirchherr et al., 2018). The circular economy can contribute significantly to the social dimension by creating green jobs. Such a concept can also be restricted due to a lack of trained labor, financial constraints, and experience (Agyemang et al., 2019: Kumar et al., 2017). Several governments seek to integrate the concepts of circular economy, green economy, and bioeconomy to maximize sustainability effectiveness and achieve sustainable development goals (Camilleri, 2019; D'Amato and Korhonen, 2021). A circular economy attempts to enhance the economic success and improve environmental quality by controlling resource loops and ensuring the sustainability of the environment. Furthermore, firms enhance the circular economy by using key concepts such as recycling, remanufacturing, reusing, repair and renewal to close resource loops and reduce resource consumption (Bocken et al., 2016).

2.3 Sustainability

Sustainability can be defined as a shift in company strategies and operations toward meeting the demands of stakeholders and sustaining, maintaining, and improving human and natural resources that will be required in the future (Searcy, 2011). Sustainability primarily focuses on maintaining the natural environment and promoting social fairness by considering future human needs. Firms support adopting environmental practices that aim to mitigate environmental damage and maximize economic gains (Fujii et al., 2013). Sustainability has also become popular with policymakers, affecting local, regional, national, and governments (Su et al., 2013). Furthermore, sustainability has been institutionalized into policymakers' agendas and companies' strategies. Gradually the concept becomes more ingrained in the norms that govern social interventions and affect organizational behavior (Hodgson et al., 2005). The concept of sustainability has been widely adopted due to concerns about the current level of technology, industrial production, and consumption which may threaten future generations (Geissdoerfer et al., 2017). Three performance factors must be reviewed regarding firm sustainability. Firstly, economic sustainability refers to a firm's capacity to meet customer demands and expectations. Secondly, social sustainability develops and fulfills the desires and requirements of customers (Kruggel et al., 2020. Thirdly, environmental sustainability refers to protecting and rebuilding the ecosystem for future generations (Larbi-Siaw et al., 2022). According to the previous literature, the environmental, social, and economic aspects are essential to the sustainability of the performance of companies (Evans et al., 2017; Fernando et al., 2019; Sandberg et al., 2022; Tiberius et al., 2021). Therefore, sustainability management includes activities that aim to measure, analyze, and improve economic, social, and environmental performance (Schaltegger et al., 2013).

2.4 Decision-making

Decision-making is the process of selecting the optimal alternative from many alternatives. Decision-making is characterized as a source of inspiration. Moreover, decision-making motivates employees to increase job investment and foster innovation (Da'as, 2020; Somech, 2010). According to March (1997), an organization makes decisions using accurate information. Thus, the decision-making process is affected by information processing, collection, and interpretation. Decision-making considers a significant factor in achieving eco-innovation (Ben Amara & Chen, 2021). Additionally, decision-making enables employees to generate innovative solutions (Jyoti & Rani, 2017). However, the decision-making process related to eco-innovation is influenced by social duty, risk, and experience. The firms must enhance the ability of environmental decisions. Firms must incorporate innovative and dynamic environmental behavior into strategic decision-making to maintain a competitive position (Salunke et al., 2011). Numerous academics asserted the significant effects of empowerment on eco-innovation (Ben Amara & Chen, 2021). Thus, the decision-making process may motivate eco-innovation goals and mitigate the barriers to eco-innovation (Arranz et al., 2019). Decision-making considers a vital factor in achieving a circular economy (Modgil et al., 2021). As a result, policymakers focus on making decisions in line with the concept of an emerging circular economy and sustainability (Tang and Liao, 2019). Contributing to the development of the circular economy requires shifting to sustainability to obtain superior performance results. Previous studies have emphasized the critical impact of decision-making in managing the circular economy (Kristoffersen et al., 2020). The decision-making process should overcome the obstacles of emissions and environmental pollution. Therefore, linking decision-making to the environment and sustainability contributes to the transition to a circular economy and mitigating climate change and greenhouse gas emissions (Alcantar et al., 2020).

2.5 Crisis management

Crisis management is described as the collection of pre- and post-crisis operations that aims to mitigate the implications of risks (Christensen et al., 2016). The primary purpose of crisis management is to prevent and prepare for crises and efficiently manage crises to limit actual damage (Coombs, 2015). The crisis management process is a dynamic and ongoing process that includes proactive and reactive efforts to anticipate and prepare for a crisis and resolve crises (Öcal et al., 2006). Companies face the challenge of identifying and using technologies to mitigate the consequences of crises (Ritchie, 2004). The concept of crisis management includes relief, preparedness, mitigation, and resiliency activities (Unlu et al., 2010). Therefore, many organizations are interested in developing an emergency plan to prepare for crises. Because crises affect society, disasters and sudden accidents threaten to cause severe environmental damage and harm the quality of life (Battisti & Deakins, 2017). Moreover, crisis management considers a critical factor in improving sustainability. However, crises constitute sensitive barriers hindering environmental innovation toward companies' adoption of the circular economy (Emerson & Nabatchi, 2015). For example, the lack of communication and cooperation between stakeholders reduces the development of environmentally friendly products. Hence, communication is vital in achieving crisis management (Leta & Chan, 2021). Crisis management is a process that refers to the systematic procedures and communications that organizations use to reduce the likelihood of a crisis and mitigate its impact of a crisis (Bundy et al., 2017; Pearson & Clair, 1998).

Crisis management requires strategies that increase the exploitation of core capabilities and resources to achieve superior performance and encourage sustainable environmental activities (Bruno & Finzi, 2018). Previous literature has argued the relationship between eco-innovation and crisis. According to García-Pozo et al. (2016), the economic situation and crisis control procedures support commitment to eco-innovation. Furthermore, during the economic crisis, hotels in Spain suffered from poor sustainability activities due to the weak economic situation that did not improve eco-innovation activities (Abdullah et al., 2022b; Alnoor et al., 2022b; Al-Abrrow et al., 2022). The literature that investigated the relationship between innovation, crises, and challenges recommended a comprehensive investigation of the relationship between eco-innovation and economic challenges and crises to find practical and innovative solutions to climate change under the unstable and stable conditions of the environment (Haskell et al., 2021).

2.6 Risk-taking

Risk-taking refers to the tendency of companies to engage in high-risk projects with a willingness to perform with organizational prudence in the face of uncertainty (Huybrechts et al., 2013; Kempers et al., 2019). Risk-taking can be categorized as a decision (i.e., taking managerial risks) or an outcome risk in a business context (i.e., organizational risk) (Santacruz, 2020). The literature confirms there are many determinants of risk-taking. For instance, managers' personalities, traits, and behavioral characteristics significantly influence risk-taking. In addition, risk-taking decrease the intentional exposure of an individual to the possibility of loss and danger. However, in turbulent times risk is considered inescapable. (Panno et al., 2021). Risk is integral to business, and organizational growth is contingent on risk-taking. Many practitioners are concerned with risk mitigation because risks affect organizational survival and the quality of life in societies. Risk-taking is essential to achieve sustainability (Ritzén & Sandström, 2017). According to Maroušek et al. (2015), sustainability is a combination of risk-taking, social responsibility, and experimentation that emphasizes the innovative potential as a driver of environmental innovation. Risk-taking is also critical to innovation by creating an innovative climate (Sinkula, 2002; Dai & Seol, 2014). The willingness of companies to take risks refers to reducing business risk, achieving high profits, and lowering the possibility of failure (Alvarez et al., 2020). Companies are increasingly involved in developing information systems, expert systems, and artificial intelligence mechanisms to make successful decisions that mitigate risks and inspire companies to be ready to face unexpected crises (Games & Rendi, 2019; Zhu & Matsuno, 2016).

3 Hypothesis development and theoretical model

3.1 The relationships between crisis management, decision-making, risk-taking, and eco-innovation behaviors

Crisis management is positively related to eco-innovation. It should be noted that the level of crisis management is one of the competencies linked with eco-innovation. Companies with a higher level of management of the crisis can manage their business more effectively than those with a lower management level (Al-Abrrow et al., 2019; Alnoor et al., 2022c; Albahri et al., 2021b). Many companies focus on mitigating the negative consequences of crises. Because a crisis often has an impact on the behavior of customers, employees, and partners. Organizations strive to stimulate resiliency processes to keep the well-being of society and customers the main priority. In this context, eco-innovation has the potential to expand and achieve excellent and interesting results in the field of sustainability (Broshi-Chen & Mansfeld, 2021). Nevertheless, the literature confirms that ineffective crisis management leads to weakness in establishing external partnerships and stimulating internal efficiency. Such an issue affects the development of environmentally friendly products and services (García-Pozo et al., 2016). Effective crisis management stimulates eco-innovation, creating a positive organizational reputation for companies (Singh Sandhawalia & Dalcher, 2011). Many organizations improve crisis management activities to address problems and crises threatening the organization's survival by developing eco-friendly products. Companies recognize the value of knowledge in crisis management to stimulate the exploration and exploitation of environmental ideas (Singh Sandhawalia & Dalcher, 2011). Efficient crisis management raises companies' ability to explore and exploit ideas in eco-innovation. In summary, crisis management is critical in developing products that minimize environmental damage. In addition, many companies struggle to manage crises efficiently to maintain a superior competitive position and achieve benefits for customers and society (Lichtenthaler, 2011). Therefore, we assumed that:

H1: Firms' crisis management behavior has a positive impact on their eco-innovation behavior.

Decision-making is positively and significantly related to eco-innovation. The finding of the previous studies indicated that decision-making enhances eco-innovation. Decision-making facilitates knowledge sharing within companies, allowing managers and staff to collect critical information necessary to adopt eco-innovations (Fernández-Mesa & Alegre, 2015). Additionally, decision-making improves an employee's capabilities and lowers the obstacles to eco-innovation (Sánchez & Aznar, 2015). According to De Dreu et al. (2011), decision-making achieves incredible results in eco-innovation through common social and environmental identity. Companies, managers, group leaders, and employees strive to embed issues of eco-innovation and sustainability into the decision-making processes. Scientists suggested decision-making enhances worker and manager motivation to engage in sustainable practices (Tian & Zhai, 2019; Boxall et al., 2015). Consequently, decision-making benefits eco-innovation (Chen & Tjosvold, 2006; Scott-Ladd & Chan, 2004; Ali et al., 2020). Decision-making aims to increase the leader's and subordinates' collaborative influence to motivate human resources to develop environmentally friendly innovations. Management decisions significantly affect eco-innovation (Huang et al., 2010; Da'as, 2020; Somech 2010). Many practitioners and academics attempt to enhance quality decisions in companies because there is a link between the quality of innovation and organizational decisions (Pisano, 2015). Many companies are increasing participation in decision-making and adopting concurrent engineering to create products with competitive environmental advantages (Chiu et al., 2014; Brabham, 2013). Moreover, we suggested that:

H2: Firms' decision-making behavior has a positive impact on their eco-innovation behavior.

Risk-taking is positively and significantly related to eco-innovation. There is a strong correlation between risk-taking and outbound open innovation (Oliva et al., 2022). Besides, academics argue the relationship between taking risks and external networking of open innovation is strong (Carvalho & Sugano, 2016). However, an inadequate understanding of corporate adoption of eco-innovation based on well-established technology poses enormous risks. Therefore, excessive reliance on research and development activities outside the borders through alliances and acquisitions increases the risks (Al-Abrrow et al., 2021; Albahri et al., 2021a; Alhamdi et al., 2019). Because relying on external sources reduces the internal efficiencies of eco-innovation and increases the opportunities for arm-twisting operations by supplier companies (Manzini et al., 2017). A stream of research has confirmed there is a negative relationship between risk-taking and eco-innovation (Schroll & Mild, 2011). Eco-innovation research has also revealed low risk-taking by practitioners and managers increases environmental risks and impairs innovation processes. Furthermore, low risk-taking leads to increased administrative and regulatory expenses and environmental risks for products and services (Hannen et al., 2019; Brunswicker & Chesbrough, 2018). Thus, we proposed that:

H3: Firms' risk-taking behavior has a positive impact on their eco-innovation behavior.

3.2 The relationships between eco-innovation, sustainability, and circular economy behaviors

Eco-innovation is positively and significantly related to corporate sustainability. The result shows that eco-innovation is supported by sustainability. Eco-innovation enhances social, environmental, and economic sustainability performance (Carrillo-Hermosilla et al., 2010). Developing eco products, processes, services, and technologies can advance the well-being of human needs and organizations and raise social benefits (Tello & Yoon, 2008). Moreover, sustainability-oriented eco-innovation changes the organizational culture to be focused on the environmental, social, and economic aspects of products (Adams et al., 2016). Adopting eco-innovation would undoubtedly result in company cost savings through resource preservation, energy conservation, waste reduction, and recycling (Hitchcock & Willard, 2012). Various industries focus on environmental improvements for products and services to gain customer satisfaction and reduce waste (Smerecnik & Andersen, 2011). Therefore, sustainable product innovation is an essential factor for the well-being of societies (Chaudhary & Kumar, 2021). Governments struggle to enforce laws on companies to commit to environmental innovation and increase community sustainability because such action would reduce climate change and greenhouse gas emissions. Because eco-innovation is affected by governmental laws, corporate beliefs, rules, and ethical codes (Smerecnik & Andersen, 2011). In addition, organizational capabilities, facilities, expertize, values, and processes are essential determinants of eco-innovation (Chaudhary & Kumar, 2021).

Eco-innovation can be considered the primary factor in developing sustainable business practices. Hence, eco-innovation is directly associated with sustainability issues such as climate change, resource efficiency, and waste (Kemp & Pontoglio, 2011). When corporate sustainability goals adopt a circular rather than a one-way strategy, the circular economy is the best option for deciding business policy priorities. Eco-innovation can be viewed as the main driver behind creating new corporate sustainability policies because of its direct relationship to resource efficiency, energy deficit, and climate change (Kemp, 2011). Furthermore, we proposed that:

H4: Firms' eco-innovation behavior has a positive impact on their sustainability behavior.

Eco-innovation is positively and significantly related circular economy. The finding indicates that eco-innovation enhances the circular economy in the context of the Public Companies of the Iraqi Ministry of Electricity (Alharbi & Alnoor, 2022; Alnoor, 2020; Khaw et al., 2022b). The result shows that the circular economy supports eco-innovation. The relationship between eco-innovation and the circular economy is a unique and powerful combination of creating products with superior environmental features (Alnoor et al., 2020; Eneizan et al., 2019; Fadhil et al., 2021). In addition, eco-innovation contributes to cost reduction, implementing technical solutions to produce cleaner products, organizational reconfiguration, business models, and enhanced circular economy behavior (De Jesus & Mendonça, 2018). Thus, eco-innovation activities are considered the most effective tools for achieving a circular economy and obtaining a higher level of sustainability (De Jesus et al., 2019). Firms have changed social systems to be intrinsically oriented on eco-innovation and the circular economy (Geissdoerfer et al., 2017) because eco-innovation is linked to the circular economy toward achieving clean and environmentally friendly products and services.

Eco-innovation is linked to the circular economy and is considered the operational process to increase clean production and achieve more sustainable operations in the supply and production activities (De Jesus & Mendonça, 2018). However, governments are increasing the strictness of environmental regulations to reduce the impact of companies on the well-being of current and future generations by mitigating the influence of industry on climate change (Alnoor et al., 2018; Khaw et al., 2022a; Wah et al., 2022). In this context, governments are putting pressure on companies to pay attention to the environment and reduce pollution. Circular economy activities and eco-innovation are the trends to reduce material and energy waste (Cassia et al., 2020). Likewise, the relationship between eco-innovation and the circular economy is crucial. The circular economy is oriented toward product design, and the process is environmentally friendly. In addition, academics and practitioners have established that innovation activities are linked to the circular economy. In this regard, open innovation could lead the shift to the circular economy because it strives to improve information flows, speed up the innovation process, and expand markets for the benefits that invention has on the outside. The move to the circular economy has been claimed to be driven mainly by innovation.

Similarly, eco-innovation and the circular economy are characterized by an interdisciplinary strategy with a global focus and a long-term path (De Jesus et al., 2019). The incorporation of social, economic, and environmental aspects and components that integrate sustainability practices implied highlights eco-innovation as a means of a change to the circular economy. Companies must acquire innovative capabilities, such as eco-innovations, for the circular economy to be accepted. The eco-innovation efforts will help businesses close the product life cycle loop and retrieve value from the trash. Hence, we recommended that:

H5: Firms' eco-innovation behavior has a positive influence on their circular economy behavior.

Sustainability is positively and significantly related circular economy. The finding indicates that sustainability enhances the circular economy in the context of the Public Companies of the Iraqi Ministry of Electricity. The result shows that the circular economy supports sustainability. A circular economy prioritizes waste reduction, resource extraction, and opportunities for sustainable growth (Zink & Geyer, 2017). Economic development and associated environmental sustainability have been the primary goal of the circular economy (Mathews & Tan, 2016). The relationship between the circular economy and sustainability has become a central point of debate (Sauvé et al., 2016). Sustainability is used to support an institutional commitment by reducing risks and enhancing opportunities based on the circular economy concept (Geissdoerfer et al., 2017). To promote the development of environmentally friendly products, companies must implement a circular economy throughout the product life cycle (Hildebrandt et al., 2021). According to Geissdoerfer et al. (2017), sustainability contributes to achieving positive effects toward adopting the circular economy concept in many industries. In addition, sustainability is considered a complement to the circular economy process by integrating the social, economic, and environmental aspects with the product life cycle. As a result, consumers are more receptive to green products that combine sustainability and circular economy to reduce environmental pollution (Turunen & Halme, 2021). In this regard, sustainability and circular economy are the most important issues to generate the organizational reputation (Alnoor et al., 2022c; Zaidan et al., 2022; Sandberg et al., 2022). However, the literature has argued weak environmental innovation exacerbates sustainability problems (De Jesus et al., 2019; Kanger & Schot, 2018). A circular economy involves re-thinking social systems in terms of formal and implicit laws. In addition, companies that adopt the circular economy are forced to change collective and individual behavior that encourages the adoption of new business models to achieve sustainability (Geissdoerfer et al., 2017; Pieroni et al., 2019). According to Ritzén & Sandström (2017), most companies face barriers to adopting a circular economy, such as sustainability and environmental innovation. Therefore, we assume that:

H6: Firms' sustainability behavior has a positive influence on their circular economy behavior.

3.3 Mediating role of eco-innovation

The investigation on the mediating role of eco-innovation confirms most of the hypotheses of the influence of crisis management, decision-making, and risk-taking on sustainability and circular economy through the mediating role have been accepted. However, there is a positive and significant impact through the mediating role of eco-innovation. Previous studies have confirmed the influence of crisis management, decision-making (e.g., Becken & Hughey 2013), and risk-taking (John et al., 2008) on sustainability and circular economy. Several studies claim the importance of eco-innovation to increase sustainability activities (e.g., Azar & Ciabuschi 2017). For instance, Smith and Tushman (2005) scrutinized that top management with innovative skills and capabilities acquire valuable resources essential for organizational sustainability and competitive advantage.

Moreover, eco-innovation, sustainability, and competitive advantage lead to superior performance (Alshehhi et al., 2018; Magon et al., 2018). In emerging economies, firms use various resources to gain a competitive advantage and enhance eco-innovation to encourage firm sustainability. However, crisis management is the perspective that is the most established factor that configures a firm to have a sustainable competitive advantage and success in a circular economy (Singh Sandhawalia & Dalcher, 2011). Efficient crisis management is considered an organizational capability and managerial innovation that controls corporate sustainability activities (Ferasso & Alnoor, 2022). Crisis management improves strategic planning and reduces the effect of the crisis and decision-making processes related to a troubled environment (Olsson et al., 2014). In this thought, decision-making facilitates organizations to configure the eco-innovation that can become a significant way to gain high sustainability.

Moreover, decision-making and risk-taking is a global competition and a source of competitive advantage essential for business success (Oliva et al., 2022; Rogers, 2004). Risk-taking enables firms to build a sustainable position and achieve eco-innovation success in a turbulent market, configuring profitability and a high circular economy (Carvalho & Sugano, 2016). For instance, Hannen et al. (2019) claimed risk-taking assists firms in acquiring valuable resources that can quiet the internal processes and structure of a firm which in turn significantly improves eco-innovation and sustainability. Furthermore, eco-innovation plays an essential role by producing more significant outputs from similar resources to stimulate sustainability and improve performance and circular economy (Coccia, 2017). For instance, innovation enables firms to acquire different resources crucial for high performance and environmental competitiveness (Lee & Grewal, 2004).

The eco-innovation encourages innovations, sustainability, and corporate operations linked to a circular economy. Decision-making contributes to increasing sustainable economic activities by stimulating stakeholder participation in exploring environmental improvements for products (Jabbour et al., 2020). The literature concludes decision-making is related to a circular economy, sustainability, e-commerce, IT service management, emergency response, and social networking (Gou et al., 2018; Palomares et al., 2013; Wu & Xu, 2018). In this context, stakeholder participation in corporate decisions increases opportunities to create environmentally friendly products (Kunz et al., 2018). Involving stakeholders in decision-making enhances awareness of adopting a circular economy in organizational processes (Kunz et al., 2018). Eco-innovation contributes to incorporating circular economy principles into organizational beliefs and values. Circular economics is based on the concept of resource efficiency. Thus, reducing costs and mitigating crises increases the potential for resource exploitation (Linder & Williander, 2017). Distinguished crisis management leads to optimal exploitation of resources and high development at the level of sustainable activities. In other words, crisis management can be a powerful mechanism for adopting circular economy practices (Bodar et al., 2018). Many companies struggle to increase the processes of substitution of manufacturing inputs, reuse and recycle, commodify waste and achieve cost savings associated with waste disposal (Bocken et al., 2014). Therefore, crisis management improves companies' adoption of circular economy processes and enhances sustainable activities' capacity (Ripanti & Tjahjono, 2019; Ying & Li-jun, 2012; Zhu et al., 2010).

The primary objective of a circular economy is to maximize the recycling of materials and align economic growth and development with the use of the environment and resources. However, neglecting to take risks reduces the benefits of a circular economy and environmental product innovations. Risk-taking expands economic opportunities and increases prospects for transitioning to a circular economy to develop production and consumption patterns (Kazancoglu et al., 2020). As a result, risk assessment can positively affect circular economic activities. The circular economy is closely related to risk. The relationship between risk and the circular economy is essential and increases the chances of developing sustainable products (Shen et al., 2019). Companies are developing security systems tailored to boost resilience and ensure competitiveness, crisis management, and sustainability. Increased security to avoid crises is critical for increased competitiveness and sustainability (Elattar & ElSayed, 2020); Portal and Mangin, 2020). Academics have established risk management as a critical component of the sustainability model for different industries (Toubes et al., 2021). Corporate strategic plans that consider social, environmental, and economic issues support companies mitigate operational and financial risks (Terouhid & Ries, 2016). In conclusion, regulatory decisions and efficient risk management influence the exploration and exploitation of environmental ideas for products. Hence, such issues are essential determinants of sustainability and circular economy activities (Monk & Perkins 2020; Holsapple & Sena 2005).

H7: Firms' eco-innovation behavior positively moderates between their decision-making, crisis management, and risk-taking behaviors on the one hand and their sustainability and circular economy behaviors on the other hand.

4 Methodology

This section describes the methodology based on two methods, SEM and MCDM. The sample section describes the data collection process. The statistical approach section describes the MCDM methods performed to conduct a benchmarking between firms' energy sectors, as shown in Fig. 1.

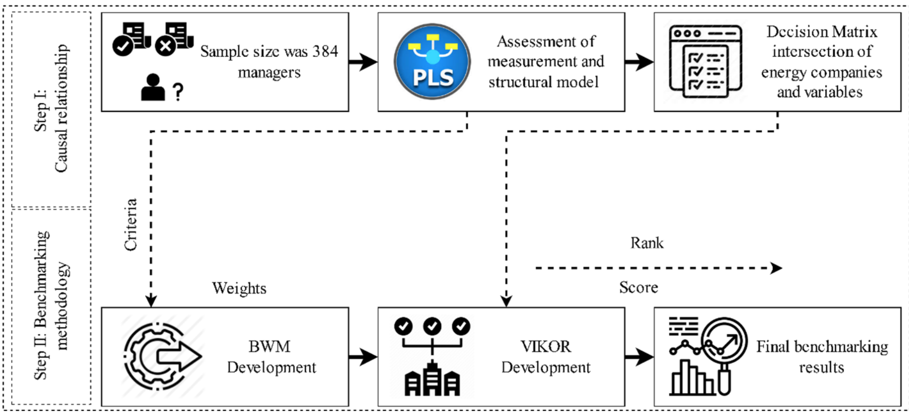

Fig. 1 Methodology steps

4.1 Sample

In recent years, the challenges faced by the energy sector in developing countries have increased. Focusing on economic, social, and environmental is a critical need in the energy industry. This study was conducted in Iraqi electricity companies. Iraqi Ministry of Electricity began growing and increasing investment in electric power generation and distribution. The first step was to rehabilitate the electric power generation, transmission, and distribution stations following a structured program based on four financial, technical, operational, and sustainable criteria to identify the qualified electric power sector capable of operating in Iraq. As a result, the Iraqi Ministry of Electricity selected 16 public businesses specializing in the production, transmission, distribution, training, operation, and repair of electrical stations. To collect information about these companies, the study consulted the Iraqi Ministry of Electricity's website and analyzed data from recent World Bank publications for the Iraq Economic Monitor 2018/2020. Additionally, the Iraqi government began importing electricity from neighboring countries (Saudi Arabia and Iran) in 2009 as a means of increasing electricity production and relieving pressure on the national grid until the required level of electric power loads was reached. Ministry of electricity aims to increase production capacity and reach 36,724 MW by 2025 and strengthen production, transmission, and distribution systems. Until 2019, many achievements have been achieved, increasing production capacity from 10,827 MW in 2017 to 19,395 MW in 2020. However, the actual production for the year 2021 was about 21,215 MW. Electricity companies currently represent the most important sector for the rest of the companies in Iraq because power is an important vital factor in developing economic, social, and industrial countries. In addition, these companies may contribute to reducing greenhouse gas emissions when investment in this sector is friendly and sustainable.

Sustainability issues and environmentally friendly innovation are among the tasks of leaders and managers in companies. Therefore, data were collected from managers and heads of departments working in 16 electricity companies in Iraq. The questionnaire was translated from English into Arabic language. Hence, the questionnaire was presented to six experts in the field of sustainability and energy to complete the pre-test process and content validity. Slight changes were made to the questionnaire, and the questionnaire was distributed online. The study population was selected from managers and heads of departments from different companies and cities (i.e., Baghdad, Basra, Babil, Mosul) in public companies of the Iraqi Ministry of Electricity. An online questionnaire was sent to 549 managers and heads of departments using different social networks. Due to the managers' preoccupation with administrative and technical tasks, 384 completed questionnaires were obtained with a 70% response rate. Therefore, the sample size is suitable and acceptable for data analysis because PLS-SEM required 200 responses (Bell et al., 2022; Hair Jr et al., 2014). The questionnaire consisted of 52 items covering the variables, and respondents answered using the five-point Likert scale to reduce respondent confusion by decreasing scale alternatives. The final sample consisted of 384 managers and heads of departments representing 55% of males and 45% of females. Diploma holders constituted the majority at 51%, while the percentage of those holding a bachelor's degree was 39% of the sample, and the percentage of master's and doctoral degrees was 10%.

The problem of method bias is common in the field of human resource research. Several preventive measures were taken, such as confirming the confidentiality of information for respondents and drafting inverse items. In addition, a single-factor Harman test (Podsakoff et al., 2003) has been performed. The bias problem appears when the variance of the first factor exceeds 50%, but in this study, the percentage was 30%. Thus, there is no concern regarding common method bias. Besides, according to Hair Jr et al. (2014), the responses will be normally distributed when the skewness and kurtosis are close to zero. Hence, the PLS-SEM results showed that all the items have skewness and kurtosis less than 1 and close to zero. Therefore, the data for this study have a normal distribution. Crisis management adopted three items scale developed by Rasoolimanesh et al. (2021) (e.g., gaining valuable experience that will help us attract and develop other partners). Decision-making was measured using a four-item scale (Han et al., 2010). Risk-taking was measured using a three-item scale developed by Sheaffer et al. (2010). The circular economy is measured employing three items scale adopted according to Patwa et al. (2021). In addition, eco-innovation was measured according to the Hojnik et al. (2018) measurement and consists of 15 items scale. This study used a five-point scale (1, strongly disagree to 5, strongly agree).

4.2 Statistical approach

This study adopted the PLS-SEM approach using SmartPLS software in the first analysis stage to test the proposed conceptual model. PLS-SEM is suitable for two purposes. Firstly, compared to co-variance-based structural equation modeling (CB-SEM), PLS-SEM is superior in predicting complex models (Ooi et al., 2021). Secondly, PLS-SEM uses slight limitations to sample size and anomalous distributions (Lew et al., 2020). Thus, PLS-SEM was considered more applicable to this study. However, PLS-SEM conducts linear relationships and cannot provide weight to variables and benchmarking for alternatives. To this end, MCDM is a method that completes the work of SEM and has the potential ability to assign weight to variables and rank alternatives.

Additionally, we use an MCDM approach. MCDM methods are divided into two types. The first aims to assign the weight, and the second aims to rank the alternatives. For weight methods, there are many types, such as Analytic Hierarchy Process (AHP), Best Worst Method (BWM), Fuzzy Weighted with Zero Inconsistency (FWZIC), and Analytic Network Process (ANP). Hence, several MCDM methods have been proposed and used in various studies to assign criteria weights, such as Weighted Sum Model (WSM) and Simple Weighted Average (SWA) (Salih et al., 2020). The BWM method is commonly used and the first method developed to assign weight to criteria, and many scholars support the use of such a technique (Alsalem et al., 2022). The literature has adopted many methods such as VIKOR, multi-objective optimization based on ratio analysis (MULTIMOORA), and Fuzzy Decision by Opinion Score Method (FDOSM) to rank the alternatives (Alnoor et al., 2022a; Khaw et al., 2021). In addition to adopting an advanced method called Ordinal Priority Approach (OPA) (Ataei et al., 2020; Mahmoudi et al., 2021a, 2021b; Mahmoudi & Javed, 2022; Mahmoudi et al., 2022a, 2022b). However, the BWM method is easy to use and reduces comparison times. The BWM method provides highly reliable results due to the small number of comparisons and provides a high degree of consistency compared to other MCDM methods (Alnoor et al., 2022a; Liu et al., 2021; Mahmoudi et al., 2022c; Sadeghi et al., 2022). To the greatest of our knowledge, none of the methods analyzed has been used to classify the Iraq power industry firms. The current study used BWM because it could provide consistent results against AHP and other MCDM weighting methods. In addition, pairwise comparisons based on BWM are lower than other methods (Gupta & Barua, 2017; Rezaei, 2015, 2016). On the contrary, the most common MCDM methods for ranking alternatives are TOPSIS and VIKOR. Such two methods use a middle-priority approach to improve multiple responses (Opricovic & Tzeng, 2007). Conversely, TOPSIS determines the alternative chosen based on proximity to the ideal solution. However, TOPSIS does not consider the relative importance of distances (Opricovic & Tzeng, 2004). In addition, VIKOR can rank the alternatives to determine the best accurately and quickly (Opricovic & Tzeng, 2007). Several examples of applying VIKOR with BWM to achieve consistency improvement for subjective weights were presented in the literature. VIKOR and BWM are easy to use and perform in a friendly computing environment (Tian et al., 2018). Thus, VIKOR and BWM were adopted to solve the problems of various actual power industry companies. However, VIKOR cannot elicit weights and verify the consistency of decision-making. Hence, several studies have recommended using BWM with VIKOR (Rezaei, 2015, 2016; Shojaie et al., 2018) due to BWM assigning weights for the criteria. BWM and VIKOR methods deal with complex decision matrices. The decision matrix for this study is the intersection between the independent and mediating variables of the conceptual model, which represents the criteria, with the electric power companies, which represent the alternatives. The following steps describe the steps of the BWM and VIKOR methods. Firstly, the BWM procedure includes the following steps.

Step 1. Determine a set of decision criteria: The first step of the BWM is determining the criteria set, $C1$, $C2$, …; Cn. In this study, the criteria set is obtained from the analysis conducted in the literature (Rezaei, 2015).
Step 2. Determine the best and worst criteria: The best criterion can be considered the most desirable or crucial for a decision. The worst criterion represents the least desirable or least essential criteria. In this step, the best and worst criteria are determined based on the decision expert's perspective of three decisions. Three developers and academic experts are selected. Experts have more than 5 years of experience. The selected experts have experience in sustainability and the electric power field (Rezaei, 2016).
Step 3. Conduct a pairwise comparison between the best criterion and the other criteria: The pairwise comparison process is conducted between the identified best criterion and the other criteria. This step aims to determine the preference of the best criterion over all the other criteria. The expert must determine a value from 1 to 9 to represent the importance of the best criterion over the other criteria (Rezaei, 2015, 2016).
Step 4. Process the pairwise comparison between the other criteria and the worst criterion: This comparison aims to identify the preference of all criteria over the least important criterion. The expert determines the importance of all the criteria over the worst criterion based on a 1 to 9 scale.
Step 5. Elicit the optimal weights (W^*1, W^*2, …W^{*n}): The optimal weight for the criteria is the one where, for each pair of W_B/Wj and Wj/Ww, we have $W_B/W_j = a_{BJ}$ and $W_j/W_w = a_{jw}$. To fulfil these conditions for all j, we should find a solution with maximum absolute differences (Rezaei, 2016).

$$\left|\frac{W_B}{W_j} - a_{Bj}\right| \text{and} \left|\frac{W_i}{W_w} - a_{Bjw}\right| \tag{1}$$

For all j are minimized. Considering the non-negativity and sum condition for the weights, the following problem is created (Rezaei, 2015, 2016).

$$\text{minmax}_j\left\{\frac{W_B}{W_j}-a_{Bj}|,\left|\frac{W_j}{W_w}-a_{jw}\right|\right\} \tag{2}$$

$$W_j \geq 0, \quad \text{for all } j$$

$$\sum_j \mathrm{W}_{\mathrm{j=1}}$$

$$\left|\frac{W_B}{W_J}-a_{Bj}\right| \leq \xi, \quad \text{for all} j \tag{3}$$

$$\left|\frac{W_j}{W_w}-a_{jw}\right| \leq \xi, \quad \text{for all} \tag{4}$$

$$\sum_j W_{j=1}$$

$$W_j \geq 0, \text{ for all } j$$

The optimal weights (w*1; w*2;…; w*n) andξ n are obtained by solving the last problem.

The value for * reflects the outcomes' reliability, depending on the extent of consistency in the comparisons. A value close to zero represents high consistency and high reliability. Hence, the consistency ratio is calculated using * and the corresponding consistency index as follows (Rezaei, 2016).

$$\text{Consistency Ratio } = \frac{\xi^*}{\text{Consistency Index}} \tag{5}$$

To rank electricity companies based on sustainability, VIKOR is utilized. In addition, such a method can provide results rapidly while determining the most suitable alternative. All the criteria weights will also be obtained from the BWM and used in the VIKOR. VIKOR steps are presented in the following Shojaie et al. (2018).

Step 1: Identify the best and worst values of all criterion functions, $i=1; 2; \ldots; n$. If the ith function represents a benefit.

Step 2: The weights for each criterion are computed based on the BWM method. A set of weights from the decision maker is accommodated in the DM; this set is equal to 1. The resulting matrix can also be computed as demonstrated in the following equation (Shojaie et al., 2018).

$$WM = wi * \frac{f^*i - fij}{f^*i - f^-i} \tag{6}$$

This process will produce a weighted matrix as follows:

$$\begin{bmatrix} w_1(f^*1 - f11\ )/(f^*1 - f^-1\ ) & w_2(f^*2 - f12\ )/(f^*2 - f^-2\ ) & \cdots & w_i(f^*i - fij\ )/(f^*i - f^-i\ ) \\ w_1(f^*1 - f21\ )/(f^*1 - f^-1\ ) & w_2(f^*2 - f22\ )/(f^*2 - f^-2\ ) & \cdots & w_i(f^*i - fij\ )/(f^*i - f^-i\ ) \\ \vdots & \vdots & \vdots & \vdots \\ w_1(f^*1 - f31\ )/(f^*1 - f^-1\ ) & w_2(f^*2 - f32\ )/(f^*2 - f^-2) & \cdots & w_i(f^*i - fij\ )/(f^*i - f^-i\ ) \end{bmatrix} \tag{7}$$

Step 3: Compute the values Sj and Rj, $j=1,2,3,\ldots,J$, $i=1,2,3,\ldots,n$ by using the following equations.

$$Sj = \sum_{i=1}^{n} wi * \frac{f^*i - fij}{f^*i - f^-i} \tag{8}$$

$$Rj = \max_i wi * \frac{f^*i - fij}{f^*i - f^-i} \tag{9}$$

where wi indicates the criterion weights expressing their relative importance.
Step 4: Compute the values Qj, by the following equations.

$$Q_j = \frac{v(S_j - S^*)}{S^- - S^*} + \frac{(1 - v)(R_j - R^*)}{R^- - R^*} \tag{10}$$

where $S^* = \min_j S_j$, $S^- = \max_j S_j$
$R^* = \min_j R_j$, $R^- = \max_j R_j$
v is introduced as the weight of the strategy of 'most criteria' (or 'the maximum group utility'); here, $v=0.5$.
Step 5: The set of alternatives can be ranked by sorting the values S, R and Q in ascending order. The lowest value indicates optimal performance (Shojaie et al., 2018).
Step 6: Propose as a compromise solution the alternative (a'), which is ranked the best by the measure Q (minimum) if the following two conditions are satisfied.
C1. 'Acceptable advantage':

$$Q(a'') - Q(a') \geq DQ \tag{11}$$

where (a'') is the alternative at the second position in the ranking list by Q, $DQ=1/(J-1)$, J is the number of alternatives.
C2. 'Stability' is acceptable in the decision-making context: Alternative a' It should also be the best ranked by S and R. This compromise solution is stable within the process of decision-making, which could be 'voting by majority rule' ($v>0{:}5$), 'by consensus' ($v \cong 0.5$) or 'with veto' ($v<0.5$). Here, v is the decision-making strategy weight of 'most criteria' (or 'the maximum group utility'). The Q value provides an idea of which electricity companies based on sustainability have high values of evaluation criteria than the others. According to this technique, the Electricity companies based on sustainability with high evaluation criteria values would have the lowest Q value than others (Shojaie et al., 2018). The data analysis section shows the results of the combination between the PLS-SEM method and the MCDM method.

5 Data analysis

5.1 Partial least squares structural equation modeling

The Smart PLS 3.3.3 method was used for SEM. Before starting with the finding of the hypothesis test, the validity of the convergent and discriminant tests was established. For convergent feasibility testing, factor loading (which must exceed 0.7), mean extracted variance (AVE) (which must surpass 0.5), composite reliability (CR), and Cronbach's alpha (which must exceed 0.7) were utilized. The results in Table 1 indicate that (dm2, eco10, eco15, eco5, eco9, sus10, sus15, sus16, sus20, sus21, sus4, sus5, sus6, sus6, sus7, and sus8) were removed due to their values have been recorded less than 0.7. However, the remaining items were more than 0.7. For CR, Cronbach's Alpha was above 0.7. Besides, AVE was more than 0.5. Hence, there is no concern regarding convergent validity values.

The discriminant validity test verifies that a specific idea scale is distinct from another in the same model. Fornell and Larcker were utilized to ensure that all ratio values were above the beside and below correlation. As shown in Table 2, the data did not exhibit a problem with discriminative validity.

In PLS analysis, the second phase is model evaluation and hypothesis testing. The direct and indirect links between the mediator variables will be evaluated. In addition to the mediator variable's influence on the two dependent variables, we will examine the value of R2, which reflects the magnitude of the effect of the exogenous variable on the endogenous variable. The results are summarized in Table 3; Fig. 2.

The results indicate the relationships between crisis management, decision-making, risk-taking, and eco-innovation are positive and significant ($\beta=0.254$, $p<0.05$; $\beta=0.142$, $p<0.05$; $\beta=0.472$, $p<0.05$). Thus, hypotheses 1, 2, and 3 are supported. In addition, the relationship of eco-innovation with circular economy and sustainability is significant and positive ($\beta=0.657$, $p<0.05$; $\beta=0.883$, $p<0.05$). Furthermore, hypotheses 4 and 5 are supported. Regarding the mediating effect of eco-innovation, the results demonstrate that eco-innovation has a fully mediating role in the relationship between the independent variables and the circular economy. Hence, there are positive and significant relationships between crisis management, decision-making, risk-taking, circular economy, and sustainability through the mediator variable of eco-innovation ($\beta=0.211$, $p<0.05$; $\beta=0.225$, $p<0.05$; $\beta=0.117$, $p<0.05$; $\beta=0.125$, $p<0.05$; $\beta=0.391$, $p<0.05$; $\beta=0.416$, $p<0.05$) respectively.

In addition, as shown in Table 3 and Fig. 2. There was an essential role for eco-innovation in increasing the positive impact of the three independent variables on circular economy and sustainability.

5.2 Multi-criteria decision-making

As mentioned earlier, the BWM method has been adopted to assign weight criteria. This method has been combined with the VIKOR method to rank electric power sector companies in terms of sustainability. Previous literature recommended asking questions to a group of experts to conduct pairwise comparisons and complete the weight recording of the criteria. Table 4. shows the expert survey method.

Afterwards, the experts selected the most important and least important criterion over the others. Previous literature recommended using three experts from the field of

Table 1 Convergent tests

Variables	Items	Loading factor	CA	CR	AVE
Circular economy	ce1	0.851	0.751	0.858	0.668
	ce2	0.817			
	ce3	0.783			
Crisis management	cr1	0.783	0.738	0.800	0.571
	cr2	0.741			
	cr3	0.741			
Decision-making	dm1	0.711	0.764	0.815	0.596
	dm3	0.771			
	dm4	0.829			
Eco-innovation	eco1	0.766	0.921	0.933	0.558
	eco11	0.728			
	eco12	0.754			
	eco13	0.758			
	eco14	0.734			
	eco2	0.750			
	eco3	0.762			
	eco4	0.752			
	eco6	0.734			
	eco7	0.762			
	eco8	0.714			
Risk-taking	rt1	0.832	0.739	0.852	0.657
	rt2	0.803			
	rt3	0.797			
Sustainability	sus1	0.750	0.940	0.948	0.564
	sus11	0.701			
	sus12	0.764			
	sus13	0.749			
	sus14	0.704			
	sus17	0.775			
	sus18	0.760			
	sus19	0.805			
	sus2	0.724			
	sus22	0.785			
	sus23	0.726			
	sus24	0.777			
	sus3	0.783			
	sus9	0.703			

specialization to perform pairwise comparisons (Albahri et al., 2021a). To this end, this study used the judgment of three experts in order to determine the weight of the criteria to complete the benchmarking process for energy companies. Thus, the BWM method was used by targeting three experts in the field of sustainability, and a questionnaire was given to experts to determine the best and worst criteria. In addition, expert opinions were obtained and applied, as shown in Fig. 3.

Table 2 Discriminant validity

Variables	1	2	3	4	5	6
1. Circular economy	**0.817**					
2. Crisis management	0.617	**0.756**				
3. Decision-making	0.597	0.701	**0.772**			
4. Eco-innovation	0.729	0.673	0.650	**0.747**		
5. Risk-taking	0.670	0.660	0.668	0.734	**0.811**	
6. Sustainability	0.724	0.685	0.614	0.683	0.731	**0.751**

These values should be more than the subcorrelations also we mentioned that in your paper

For the first expert, the most important criterion was sustainability, and the worst was crisis management. For the second expert, the best criterion was eco-innovation and sustainability, and the worst was crisis management. For the third expert, the best criterion was eco-innovation, and the worst was crisis management. In conclusion, experts agree that eco-innovation and sustainability are essential to achieving a circular economy in the energy sector.

To benchmark the energy sector companies, the VIKOR method was adopted. The ranking of companies in the electric power industry adopting a circular economy is based on the weight of criteria presented by three experts. In addition, benchmarking was used based on individual and group decision-making. Table 5. displays the ranking of the energy sector companies according to the assigned weight of three experts.

According to each expert's Q and Order, Company 2, Company 4, and Company 3 got the highest rank. Company 11, Company 15, and Company 14 got the worst rank, respectively, for the first and second experts. Company 4, Company 2, and Company 3 got the best rank for the third expert. Company 11, Company 15, and Company 14 got the worst rank. Based on the matching of 68.75%. Based on matching among experts for the ranking of electric power companies according to a circular economy, there is 32% matching among experts in the ranking of companies. However, about 68.75% of the rankings do not match. To this end, the rank according to the internal and external groups is an urgent need. Table 6. shows the ranking of companies according to the circular economy based on the decision-making group.

For the internal group, Company 6, Company 15, and Company 13 got the best rank. Company 7, Company 9, and Company 11 got the worst rank. For the external group, Company 4, Company 2, and Company 3 got the best rank. Company 11, Company 15, and Company 14 got the worst rank. Validation is an urgent need to deal with issues of the generalizability of results. The process consists of objective validation, subject validation, sensitivity analysis, Spearman's rank correlation, and comparative analysis. This study adopted an objective validation method to ensure that the ranking of the energy sector companies is subject to a systematic classification.

The objective validation method has been widely used in the context of MCDM. The objective validation method includes compiling an opinion matrix to produce a unified opinion matrix and ranking the energy sector companies within the unified opinion matrix. The energy sector companies are separated into three groups. Hence, the mean of each group is obtained. Based on the results of the comparison, the results of the arithmetic mean of the first group should be less than or equal to the mean of the second group. Similarly, the results of the second group must be less than or equal to the results of the

Table 3 Assessment of structural model

Path	(O)	(M)	(STDEV)	(|O/STDEV|)	*P* values	Result
Direct effect						
Crisis management → Eco-innovation	0.254	0.261	0.071	3.586	0.000	Supported
Decision-making → Eco-innovation	0.142	0.141	0.068	2.092	0.037	Supported
Eco-innovation → Circular economy	0.657	0.649	0.097	6.737	0.000	Supported
Eco-innovation → Sustainability	0.883	0.884	0.016	55.757	0.000	Supported
Risk-taking → Eco-innovation	0.472	0.469	0.060	7.899	0.000	Supported
Sustainability → Circular economy	0.195	0.202	0.101	1.931	0.048	Supported
Indirect effect						
Crisis management → Eco-innovation → Circular economy	0.211	0.216	0.058	3.614	0.000	Supported
Crisis management → Eco-innovation → Sustainability	0.225	0.231	0.062	3.599	0.000	Supported
Decision-making → Eco-innovation → Circular economy	0.117	0.117	0.056	2.086	0.037	Supported
Decision-making → Eco-innovation → Sustainability	0.125	0.125	0.060	2.089	0.037	Supported
Risk-taking → Eco-innovation → Circular economy	0.391	0.389	0.052	7.570	0.000	Supported
Risk-taking → Eco-innovation → Sustainability	0.416	0.415	0.055	7.522	0.000	Supported

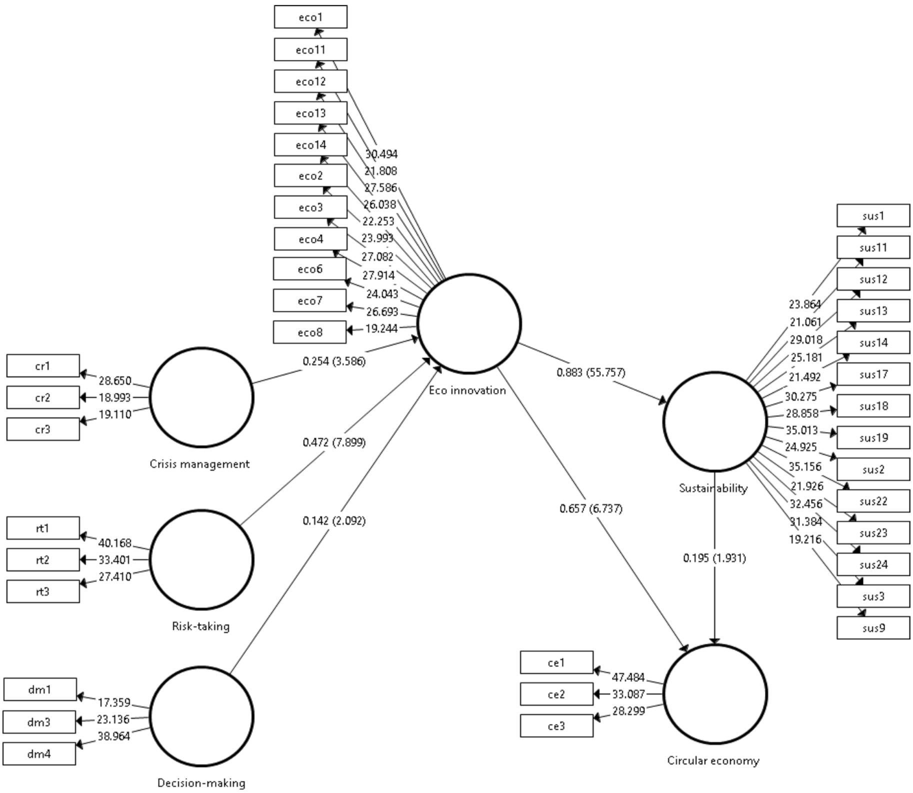

Fig. 2 Hypotheses test

Table 4 Comparison to determine the most and least important criteria

Main criteria	Most important	Least important
Decision-making		
Crisis management		
Risk-taking		
Eco-innovation		
Sustainability		

arithmetic mean of the third group. Validation was tested based on the internal group. Table 7. Illustrated the validation results.

Regarding the results of validating the group decision-making of companies in the energy sector, the arithmetic mean in the first group is lower than the arithmetic mean in the second group. The arithmetic mean in the second group was lower than the arithmetic mean in the third group. Accordingly, the first group has a lower value than the second group, and the second group has a lower value than the third group of companies

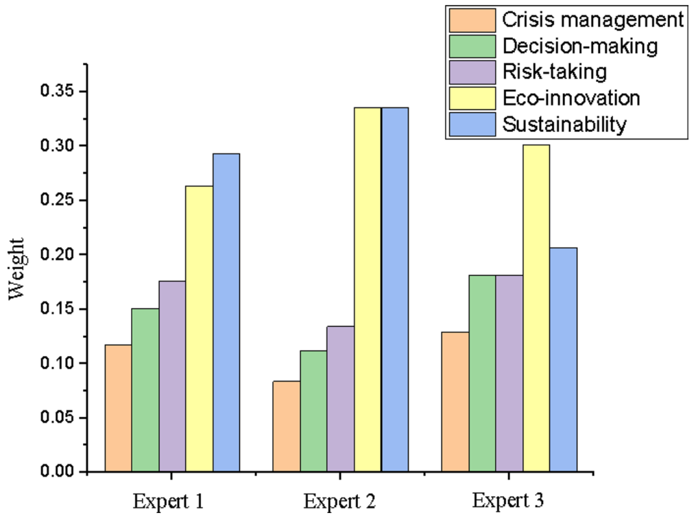

Fig. 3 The results of the BWM method for weight criteria

Table 5 Ranking results based on the three experts' weights

Companies	Expert 1		Expert 2		Expert 3	
	Q	Order	*Q*	Order	*Q*	Order
Company 1	0.284	4	0.278	4	0.277	7
Company 2	0.022	1	0.015	1	0.032	2
Company 3	0.085	3	0.079	3	0.074	3
Company 4	0.030	2	0.029	2	0.000	1
Company 5	0.313	6	0.301	5	0.212	5
Company 6	0.388	8	0.425	8	0.434	8
Company 7	0.544	13	0.542	13	0.496	12
Company 8	0.493	9	0.489	9	0.444	10
Company 9	0.511	11	0.521	11	0.518	13
Company 10	0.303	5	0.301	6	0.270	6
Company 11	0.707	14	0.711	14	0.668	14
Company 12	0.510	10	0.515	10	0.471	11
Company 13	0.517	12	0.529	12	0.442	9
Company 14	1.000	16	0.992	16	0.983	16
Company 15	0.812	15	0.900	15	0.887	15
Company 16	0.365	7	0.380	7	0.168	4

in the energy sector. Moreover, the ranks are valid and subject to the standard classification of the energy sector companies.

Table 6 Ranking results based on the internal and external group

Companies	Internal group		External group	
	Q	Order	*Q*	Order
Company 1	0.384	6	0.280	5
Company 2	0.535	9	0.023	2
Company 3	0.341	5	0.079	3
Company 4	0.685	13	0.020	1
Company 5	0.637	11	0.275	4
Company 6	0.000	1	0.416	8
Company 7	0.765	14	0.527	13
Company 8	0.419	7	0.475	9
Company 9	0.793	15	0.517	12
Company 10	0.420	8	0.291	6
Company 11	1.000	16	0.695	14
Company 12	0.559	10	0.499	11
Company 13	0.198	3	0.496	10
Company 14	0.313	4	0.992	16
Company 15	0.110	2	0.866	15
Company 16	0.684	12	0.304	7

Table 7 Validation results of group decision-making rank

Internal	
Group	Arithmetic mean
Group 1	0.022
Group 2	0.070
Group 3	0.120

6 Discussion

The results of the current study confirmed crisis management behavior has a positive and significant impact on eco-innovation behavior. The findings of the eco-innovation studies show a significant relationship between crisis management and eco-innovation behaviors. Hence, the findings of this study are consistent with previous literature indicating that there are interactions between crisis management factors and eco-innovation (Bryksina et al., 2018; Fernández-Mesa & Alegre, 2015). In this context, electricity companies must focus on their crisis management to move toward eco-innovation. Previous studies indicated the importance of the role of crisis management in increasing eco-innovation activities. Most governments tend to establish crisis management teams aligned with corporate policies to mitigate high-cost risks and overcome the challenges of exploring and exploiting environmentally friendly products. Therefore, the results of this study confirm that electric power companies include a crisis management policy in their organizational strategy. In addition, the current study claims interesting results by emphasizing the vital role of decision-making in achieving eco-innovation. Hence, there is a significant relationship between decision-making and eco-innovation. Decision-making is considered the critical concept of eco-innovation because decisions can create opportunities and new ideas that increase learning and differentiation for companies. The process of eco-innovation increases organizational openness to adopt environmental ideas. Therefore, the energy companies' decision-making processes for this study are of high quality because such firms focus on environment-friendly products and services. The results of this study are consistent with previous literature (e.g., Ali et al., 2020). According to previous studies, flexibility in decision-making is also essential to increasing environmental innovation (Chen & Tjosvold, 2006; Scott-Ladd & Chan, 2004).

As mentioned previously, many companies and governments realize risk-taking must be given the highest priority due to increased competitive and regulatory pressures (Oliva et al., 2022). The results demonstrated a significant relationship between risk-taking and eco-innovation. Firms face diverse and ferocious competitive and regulatory forces. Organizations pursue to enhance competitiveness and control the activities of competitors to restrict and prevent new firms from entering the competitive field. Therefore, risk-taking is a critical factor in maintaining a competitive position. The results of this study indicate that energy companies focus on creating high environmental opportunities to prevent competitors from entering the market. Previous literature supports such arguments (e.g., Carvalho & Sugano 2016). Therefore, compared to the literature, the results confirmed that risk-taking influences eco-innovation in the energy industry. The empirical findings align with previous research by confirming that the positive perceptions of managers toward risks increase the development of environmental innovation and performance improvement (Brunswicker & Chesbrough, 2018).

Additionally, eco-innovation has a positive and significant relationship with the circular economy. This result is consistent with previous studies (e.g., De Jesus & Mendonça, 2018). Effective management of electricity companies can provide environmental-friendly products and services by reducing risk and waste. Likewise, providing products and services with the least required sustainability enables companies to achieve competitive priorities in terms of circular economy and sustainability. Eco-innovation activities help electricity companies to reduce production costs and increase competitive strategy.

Furthermore, the energy sector embraces a circular economy behavior and satisfies consumers' desires. This result is consistent with the literature (e.g., Geissdoerfer et al., 2017). The application of eco-innovation has increased the circular economy. Adopting a circular economy strategy is the first step to long-term survival. Eco-innovation behavior is mediating the relationship between crisis management factors (i.e., crisis management, decision-making, and risk-taking behaviors) and circular economy behavior. This result is consistent with the previous literature (Dubey et al., 2017). Crisis management factors and eco-innovation have been instrumental in business practices. The empirical evidence of previous studies supports the argument that eco-innovation is essential to the circular economy because business success is linked to sustainability (Bolton & Foxon, 2015). The current study showed interesting results: eco-innovation behavior mediates the relationships between crisis management and environmental performance factors.

Moreover, eco-innovation is a base source of sustainability. The fact that electricity companies support this argument is looking for new ideas and products and emphasizing innovation. Therefore, adopting and implementing eco-innovation enhances the circular economy of electricity companies. To overcome fierce competition, electricity companies need to constantly adapt strategies based on exploring and exploiting environmental ideas for products and services. This result is in line with the previous literature (Carrillo-Hermosilla et al., 2010). Therefore, eco-innovation is mediating in improving electricity companies' sustainability and circular economy. Businesses are turning and engaging in novel ecological production methods to improve sustainability and the circular economy

(Carrillo-Hermosilla et al., 2010). Getting highly sustainable products is attractive to many beneficiaries. Thus, consumers prefer sustainable products and services over cost. Companies are using new ecological production to enhance sustainability and the circular economy. According to Ramkumar et al. (2022), eco-innovation plays a substantial role in achieving sustainable competitive advantage by improving decision-making processes, managing crises and hazards and mitigating risks. The literature indicates that eco-innovation drives companies to increase economic, social, and environmental activities (Hannen et al., 2019; Zaidan et al., 2022). The result indicated that energy companies had supported the practice of eco-innovation.

6.1 Theoretical implications

This study presents several vital theoretical implications for literature and academics. Firstly, the literature should investigate the barriers that hinder the practice of environmental innovation activities. Companies face many barriers that reduce sustainability, such as crisis management factors. Crisis management factors include internal and external barriers. External barriers relate to high fuel and raw materials costs, insufficient regulation of electric companies, and insufficient production. Managers face a variety of internal and external barriers. This study demonstrated that such obstacles prevent companies from adopting environmental innovation. Therefore, future literature can explore more barriers. Academics should focus on exploring additional barriers that can hinder adopting and using eco-innovation, sustainability, and the circular economy. Secondly, most of the literature has focused on exploring the role of sustainability in performance. In addition, the sustainability content has been defined by circular economy and eco-innovation (Karakaya et al., 2014; Kesidou & Demirel, 2012). The empirical findings in this research shed light on the environmental innovation of energy companies in Iraq. We introduce a new theoretical perspective to environmental innovation by integrating concepts of environmental innovation, sustainability, circular economy, and crisis management variables (crisis management, decision-making, and risk-taking). Likewise, a hybrid approach was applied to explore linear relationships based on PLS-SEM and provide insight to determine the best and worst company based on the circular economy according to MCDM methods. Adopting a dual-stage PLS-SEM and MCDM approach enables a deep insight into how energy companies are concerned with the circular economy and sustainability.

In line with previous studies in the field of eco-innovation (Halila & Rundquist, 2011), the findings of this paper indicate crisis management factors influence the sustainability of companies in the energy sector. In addition, this study expands the scope of the determinants of circular economy and sustainability by empirically examining the impact of crisis management factors on circular economy and eco-innovation. Previous findings underscore the importance of crisis management factors for eco-innovation (Pieroni et al., 2019; Sariatli, 2017). Accordingly, there are claims that environmental innovation is essential in companies' decisions to implement circular economy activities and increase financial performance. Therefore, this study contributes to the literature by extending the application mechanism to include linear and nonlinear methods. Thus, this study complements the results of the previous literature and claims the vital role of eco-innovation in the circular economy.

6.2 Practical implications

The practical implications involve many vital phases. Moreover, this study focuses on raising the awareness of managers and heads of departments in the energy sector to improve the crisis management process by increasing opportunities for the exploitation and exploration of environmental ideas. Practitioners should explore opportunities that increase eco-innovation among corporate activities, lower costs, and increase renewable energy production. To this end, practitioners and policymakers must combine the advantages of learning and efficiency. However, the results of this study confirm that crisis management factors (crisis management, decision-making, and risk-taking) are determinants of the circular economy and the adoption of environmental products. Therefore, practitioners should be concerned with increasing the quality of decisions, managing crises wisely and reducing risks by including eco-innovation processes in the organizational strategy. Eco-innovation will help companies facilitate the creation of new ideas about sustainability and the adoption of a circular economy. Besides, managers can provide financial and non-financial rewards and incentives for environmental ideas for products.

The management of electricity companies can create a favorable context for environmental openness, such as encouraging the sustainability of the services and products and creating more opportunities for human resources to participate in the decision-making process. Policymakers in electricity companies must create a culture and code of ethics that focus on sustainability. Moreover, an organizational culture that stimulates environmental innovation and sustainability would encourage human resources to adopt a circular economy. Electricity company managers must wisely analyze environmental barriers, regulatory resources, and crisis management factors to develop eco-innovations. Managers must understand that having organizational resources and capabilities may not lead to superior financial performance when neglecting sustainability programs. Policymakers should incentivize firms with high circular economy activities according to the MCDM classification by offering incentives and rewards. In addition, practitioners can impose government sanctions and regulations on companies with inadequate ranking. Thus, governments reduce the problems of environmental pollution and gas emissions from the combustion of fossil fuels used in the production of electric power. The government and responsible authorities should provide resources and support to electric power companies, which will significantly support the activities of the circular economy—the results guide practitioners and developers in understanding the factors that need improvement. In Iraq, organizations still use conventional techniques and technologies in their energy industry activities, such as processing, production, distribution, etc. This research presents several significant implications for sustainability orientation in the energy sector. Lack of technology and innovation and poor government policies are the two most significant issues in the effective adoption of a circular economy and sustainability in the energy industry in Iraq. From an organizational context, the advancement of technologies and innovation helps reduce energy wastage and improve the overall production and distribution quality.

7 Conclusion

This study examined the impact of crisis management factors (crisis management, decision-making, and risk-taking behaviors) on achieving sustainability and circular economy goals through the mediating role of eco-innovation. Crisis management, decision-making, and risk-taking behaviors were considered independent variables, eco-innovation behavior as a mediating variable and sustainability and circular economy behaviors were dependent variables. This study used a dual-stage PLS-SEM and MCDM approach based on data collected from 384 heads of departments and senior managers of energy companies in Iraq. The results indicate that crisis management, decision-making and risk-taking behaviors are linked significantly and positively to eco-innovation behavior. This study confirms the significant and positive impact of eco-innovation behavior on sustainability and circular economy behaviors. Likewise, eco-innovation is fully mediated in the relationship between crisis management, decision-making and risk-taking behaviors, and sustainability and circular economy behaviors.

Furthermore, crisis management factors have a critical role in activating sustainability and the circular economy throughout eco-innovation. Ranking energy companies according to the circular economy can support policymakers' decisions to renew contracts with the best companies in the ranking. Practitioners can also impose government regulations on companies that rank worst in sustainability. Thus, governments reduce the problems of environmental pollution and emissions of greenhouse gases.

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Data availability The data of the paper, which support the analysis and results of this paper, are available with the corresponding author, and the data can be obtained from the authors upon request.

Declarations

Conflict of interest All the authors of this paper declare no mutual conflict of interest.

Ethical approval All the procedures adopted by the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants of the study.

References

Abdul Latif, S. N., Chiong, M. S., Rajoo, S., Takada, A., Chun, Y. Y., Tahara, K., & Ikegami, Y. (2021). The trend and status of energy resources and greenhouse gas emissions in the malaysia power generation mix. *Energies*, *14*(8), 1–26.

Abdullah, H. O., Atshan, N., Al-Abrrow, H., Alnoor, A., Valeri, M., & Bayram, G. E. (2022a). Leadership styles and sustainable organizational energy in family business: Modeling non-compensatory and nonlinear relationships. *Journal of Family Business Management*. (ahead-of-print).

Abdullah, H. O., Thajil, K. M., Alnoor, A., Al-Abrrow, H., Khaw, K. W., Chew, X., et al. (2022b). Predicting determinants of use mobile commerce through modelling non-linear. *Central European Business Review*, *11*, 0–24.

Adams, R., Jeanrenaud, S., Bessant, J., Denyer, D., & Overy, P. (2016). Sustainability-oriented innovation: A systematic review. *International Journal of Management Reviews*, *18*(2), 180–205.

Agyemang, M., Kusi-Sarpong, S., Khan, S. A., Mani, V., Rehman, S. T., & Kusi-Sarpong, H. (2019). Drivers and barriers to circular economy implementation: An explorative study in Pakistan's automobile industry. *Management Decision*, *57*(4), 971–994.

Al-Abrrow, H., Ali, J., & Alnoor, A. (2022). Multilevel influence of routine redesigning, legitimacy and functional affordance on sustainability accounting: Mediating role of organizational sense-making. *Global Business Review*, *23*(2), 287–312.

Al-Abrrow, H., Alnoor, A., & Abbas, S. (2019). The effect of organizational resilience and CEO's narcissism on project success: Organizational risk as a mediating variable. *Organization Management Journal*, *16*(1), 1–13.

Al-Abrrow, H., Fayez, A. S., Abdullah, H., Khaw, K. W., Alnoor, A., & Rexhepi, G. (2021). Effect of open-mindedness and humble behavior on innovation: Mediator role of learning. *International Journal of Emerging Markets* 1–20 ahead-of-print No. ahead-of-print.

Albahri, A. S., Alnoor, A., Zaidan, A. A., Albahri, O. S., Hameed, H., Zaidan, B. B., & Yass, A. A. (2021b). Based on the multi-assessment model: Towards a new context of combining the artificial neural network and structural equation modelling: A review. *Chaos Solitons & Fractals*, *153*(1), 1–17.

Albahri, A. S., Alnoor, A., Zaidan, A. A., Albahri, O. S., Hameed, H., Zaidan, B. B., & Yass, A. A. (2021a). Hybrid artificial neural network and structural equation modelling techniques: A survey. *Complex & Intelligent Systems*, *8*(1), 1781–1801.

Alhamdi, M., Noor, R. M. A. S., Abdulla, M., Alnoor, A., & Eneizan, B. (2019). How does financial analysis influence the firm's failure in the Iraqi private sector? *The Journal of Social Sciences Research*, *5*(9), 1321–1328.

Alharbi, R., & Alnoor, A. (2022). *The influence of emotional intelligence and personal styles of dealing with conflict on strategic decisions*. PSU Research Review. (ahead-of-print).

Ali, S. A., Parvin, F., Pham, Q. B., Vojtek, M., Vojteková, J., Costache, R., & Ghorbani, M. A. (2020). GIS-based comparative assessment of flood susceptibility mapping using hybrid multi-criteria decision-making approach, Naïve Bayes tree, bivariate statistics and logistic regression: A case of Topľa basin, Slovakia. *Ecological Indicators*, *117*(10), 1–23.

Almutairi, K., Hosseini Dehshiri, S. J., Hosseini Dehshiri, S. S., Mostafaeipour, A., Hoa, A. X., & Techato, K. (2022). Determination of optimal renewable energy growth strategies using SWOT analysis, hybrid MCDM methods, and game theory: A case study. *International Journal of Energy Research*, *46*(5), 6766–6789.

Alnoor, A. (2020). Human capital dimensions and firm performance, the mediating role of knowledge management. *International Journal of Business Excellence*, *20*(2), 149–168.

Alnoor, A. M., Al-Abrrow, H., Abdullah, H., & Abbas, S. (2020). The impact of self-efficacy on employees' ability to accept new technology in an Iraqi university. *Global Business and Organizational Excellence*, *39*(2), 41–50.

Alnoor, A., Al-Abrrow, H., Halbusi, A., Khaw, H., Chew, K. W., Al-Maatoq, X., M. and, & Alharbi, R. K. (2022b). Uncovering the antecedents of trust in social commerce: An application of the non-linear artificial neural network approach. *Competitiveness Review*, *32*(3), 492–523.

Alnoor, A., Eneizan, B., Makhamreh, H. Z., & Rahoma, I. A. (2018). The effect of reverse logistics on sustainable manufacturing. *International Journal of Academic Research in Accounting Finance and Management Sciences*, *9*(1), 71–79.

Alnoor, A., Khaw, K. W., Al-Abrrow, H., & Alharbi, R. K. (2022c). The hybrid strategy on the basis of Miles and Snow and Porter's strategies: An overview of the current state-of-the-art of research. *International Journal of Engineering Business Management*, *14*(1), 1–18.

Alnoor, A., Zaidan, A. A., Qahtan, S., Alsattar, H. A., Mohammed, R. T., Alazab, M., et al. (2022a). Toward a sustainable transportation industry: Oil company benchmarking based on the extension of linear diophantine fuzzy rough sets and multicriteria decision-making methods. *IEEE Transactions on Fuzzy Systems*.

Alsalem, M. A., Alsattar, H. A., Albahri, A. S., Mohammed, R. T., Albahri, O. S., Zaidan, A. A., & Jumaah, F. M. (2021). Based on T-spherical fuzzy environment: A combination of FWZIC and FDOSM for prioritising COVID-19 vaccine dose recipients. *Journal of Infection and Public Health*, *14*(10), 1513–1559.

Alsalem, M. A., Mohammed, R., Albahri, O. S., Zaidan, A. A., Alamoodi, A. H., Dawood, K., & Jumaah, F. (2022). Rise of multiattribute decision-making in combating COVID-19: A systematic review of the state-of-the-art literature. *International Journal of Intelligent Systems*, *37*(6), 3514–3624.

Alshehhi, A., Nobanee, H., & Khare, N. (2018). The impact of sustainability practices on corporate financial performance: Literature trends and future research potential. *Sustainability*, *10*(2), 494.

Alvarez, M., Campo, S., & Fuchs, G. (2020). Tourism in conflict zones: Animosity and risk perceptions. *International Journal of Culture Tourism and Hospitality Research*, *14*(2), 189–204.

Arranz, N., Arroyabe, M. F., Molina-García, A., & De Arroyabe, J. F. (2019). Incentives and inhibiting factors of eco-innovation in the spanish firms. *Journal of Cleaner Production*, *220*(2), 167–176.

Ataei, Y., Mahmoudi, A., Feylizadeh, M. R., & Li, D. F. (2020). Ordinal priority approach (OPA) in multiple attribute decision-making. *Applied Soft Computing*, *86*, 105893.

Azar, G., & Ciabuschi, F. (2017). Organizational innovation, technological innovation, and export performance: The effects of innovation radicalness and extensiveness. *International Business Review*, *26*(2), 324–336.

Battisti, M., & Deakins, D. (2017). The relationship between dynamic capabilities, the firm's resource base and performance in a post-disaster environment. *International Small Business Journal*, *35*(1), 78–98.

Becken, S., & Hughey, K. F. (2013). Linking tourism into emergency management structures to enhance disaster risk reduction. *Tourism Management*, *36*(2), 77–85.

Bell, E., Harley, B., & Bryman, A. (2022). *Business research methods*. Oxford University Press.

Ben Amara, D., & Chen, H. (2021). The impact of participative decision-making on eco-innovation capability: The mediating role of motivational eco-innovation factors. *Environment Development and Sustainability*, *23*(5), 6966–6986.

Bocken, N. M., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of industrial and production engineering*, *33*(5), 308–320.

Bocken, N. M., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of cleaner production*, *65*(2), 42–56.

Bodar, C., Spijker, J., Lijzen, J., Waaijers-van der Loop, S., Luit, R., Heugens, E., & Traas, T. (2018). Risk management of hazardous substances in a circular economy. *Journal of Environmental Management*, *212*(2), 108–114.

Bolton, R., & Foxon, T. J. (2015). Environmental innovation and societal transitions. *Environmental Innovation and Societal Transitions*, *14*(2), 165–181.

Bossle, M. B., de Barcellos, M. D., Vieira, L. M., & Sauvée, L. (2016). The drivers for adoption of eco-innovation. *Journal of Cleaner Production*, *113*(2), 861–872.

Bouncken, R. B., & Tiberius, V. (2021). Legitimacy processes and trajectories of co-prosumption services: Insights from coworking spaces. *Journal of Service Research*. https://doi.org/10.1177/10946705211050208.

Boxall, P., Hutchison, A., & Wassenaar, B. (2015). How do high-involvement work processes influence employee outcomes? An examination of the mediating roles of skill utilisation and intrinsic motivation. *The International Journal of Human Resource Management*, *26*(2), 1737–1752.

Brabham, D. C. (2013). *Using crowdsourcing in government* (pp. 1–42). Washington, DC: IBM Center for the Business of Government.

Broshi-Chen, O., & Mansfeld, Y. (2021). A wasted invitation to innovate? Creativity and innovation in tourism crisis management: A QC&IM approach. *Journal of Hospitality and Tourism Management*, *46*(2), 272–283.

Brunke, J. C., Johansson, M., & Thollander, P. (2014). Empirical investigation of barriers and drivers to the adoption of energy conservation measures, energy management practices and energy services in the swedish iron and steel industry. *Journal of Cleaner Production*, *84*(2), 509–525.

Bruno, V. A., & Finzi, G. (2018). Leading through a decade of Crisis—Not bad, after all: Germany's Leadership demand and followership inclusion, 2008–2018. *German Politics and Society*, *36*(4), 50–77.

Brunswicker, S., & Chesbrough, H. (2018). The adoption of Open Innovation in large firms: Practices, Measures, and risks a survey of large firms examines how firms approach open innovation strategically and manage knowledge flows at the project level. *Research-Technology Management*, *61*(1), 35–45.

Bryksina, N., Golovina, A., & Legotin, F. (2018). Implementation of cost Leadership Strategy by Russian Medical Companies of Laboratory Diagnostics. In *Leadership for the future sustainable development of business and education* (pp. 189–198). Cham: Springer.

Bundy, J., Pfarrer, M. D., Short, C. E., & Coombs, W. T. (2017). Crises and crisis management: Integration, interpretation, and research development. *Journal of Management*, *43*(6), 1661–1692.

Camilleri, M. A. (2019). The circular economy's closed loop and product service systems for sustainable development: A review and appraisal. *Sustainable Development*, *27*(3), 530–536.

Camilleri, M. A. (2020). European environment policy for the circular economy: Implications for business and industry stakeholders. *Sustainable Development*, *28*(6), 1804–1812.

Carrillo-Hermosilla, J., Río, D., P., & Könnölä, T. (2010). Diversity of eco-innovations: Reflections from selected case studies. *Journal of cleaner production*, *18*(10–11), 1073–1083.

Carvalho, E. G., & Sugano, J. Y. (2016). Entrepreneurial orientation and open innovation in Brazilian start-ups: A multicase study. *Interações (Campo Grande)*, *17*(2), 448–462.

Cassia, A. R., Costa, I., da Silva, V. H. C., & de Neto, O., G. C (2020). Systematic literature review for the development of a conceptual model on the relationship between knowledge sharing, information technology infrastructure and innovative capability. *Technology Analysis & Strategic Management*, *32*(7), 801–821.

Chaudhary, R. and Kumar, C. (2022), "Innovations and eco-sustainability: exploring the role of organizational environment", Social Responsibility Journal, Vol. 18 No. 6, pp. 1069–1088.

Chen, H., Hao, Y., Li, J., & Song, X. (2018). The impact of environmental regulation, shadow economy, and corruption on environmental quality: Theory and empirical evidence from China. *Journal of Cleaner production*, *195*(2), 200–214.

Chen, W. H., Budzianowski, W. M., & Lee, K. T. (2017). Preface–sustainable biofuels. *Energy Conversion and Management*, *100*(141), 1–20.

Chen, Y. F., & Tjosvold, D. (2006). Participative leadership by American and Chinese managers in China: The role of relationships. *Journal of Management Studies*, *43*(12), 1727–1752.

Chiu, C. M., Wang, E. T., Fang, Y. H., & Huang, H. Y. (2014). Understanding customers' repeat purchase intentions in B2C e-commerce: The roles of utilitarian value, hedonic value and perceived risk. *Information Systems Journal*, *24*(1), 85–114.

Christensen, T., Lægreid, P., & Rykkja, L. H. (2016). Organizing for crisis management: Building governance capacity and legitimacy. *Public Administration Review*, *76*(6), 887–897.

Coccia, M. (2017). Sources of technological innovation: Radical and incremental innovation problem-driven to support competitive advantage of firms. *Technology Analysis & Strategic Management*, *29*(9), 1048–1010.

Coombs, W. T. (2015). The value of communication during a crisis: Insights from strategic communication research. *Business horizons*, *58*(2), 141–148.

Coulthard, E., Norrey, J., Shortall, C., & Harris, W. E. (2019). Ecological traits predict population changes in moths. *Biological Conservation*, *233*(2), 213–219.

Da'as, R. (2020). Participation in decision making and affective trust among the teaching staff: A 2-year cross-lagged structural equation modeling during implementation reform. *International Journal of Educational Reform*, *29*(12), 77–97.

Dahlander, L., Gann, D. M., & Wallin, M. W. (2021). How open is innovation? A retrospective and ideas forward. *Research Policy*, *50*(4), 104218.

Dai, S., & Seol, Y. (2014). Water permeability in hydrate-bearing sediments: A pore-scale study. *Geophysical Research Letters*, *41*(12), 4176–4184.

D'amato, D., & Korhonen, J. (2021). Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework. *Ecological Economics*, *188*(12), 107143.

De Dreu, C. K., Nijstad, B. A., Bechtoldt, M. N., & Baas, M. (2011). Group creativity and innovation: A motivated information processing perspective. *Psychology of Aesthetics Creativity and the Arts*, *5*(1), 81–89.

De Jesus, A., & Mendonça, S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological economics*, *145*(12), 75–89.

de Jesus, A., Antunes, P., Santos, R., & Mendoça, S. (2019). Eco-innovation pathways to circular economy: Envisioning priorities through a Delphi approach. *Journal of Cleaner Production*, *228*(1), 1494–1513.

Dubey, R., Gunasekaran, A., Papadopoulos, T., Childe, S. J., Shibin, K. T., & Wamba, S. F. (2017). Sustainable supply chain management: Framework and further research directions. *Journal Of Cleaner Production*, *142*(12), 1119–1130.

Elattar, E. E., & ElSayed, S. K. (2020). Probabilistic energy management with emission of renewable micro-grids including storage devices based on efficient salp swarm algorithm. *Renewable Energy*, *153*(2), 23–35.

Emerson, K., & Nabatchi, T. (2015). Evaluating the productivity of collaborative governance regimes: A performance matrix. *Public Performance & Management Review*, *38*(4), 717–747.

Eneizan, B., Mohammed, A. G., Alnoor, A., Alabboodi, A. S., & Enaizan, O. (2019). Customer acceptance of mobile marketing in Jordan: An extended UTAUT2 model with trust and risk factors. *International Journal of Engineering Business Management*, *11*(11), 1–10.

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business model innovation for sustainability: Towards a unified perspective for creation of sustainable business models. *Business Strategy and the Environment*, *26*(5), 597–608.

Hair Jr, F., Sarstedt, J., Hopkins, M., L. & Kuppelwieser, G., V (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106–121.

Fadhil, S. S., Ismail, R., & Alnoor, A. (2021). The influence of soft skills on employability: A case study on technology industry sector in Malaysia. *Interdisciplinary Journal of Information Knowledge and Management*, *16*(1), 255–283.

Ferasso, M., & Alnoor, A. (2022). Artificial neural network and structural equation modeling in the future. *Artificial neural networks and structural equation modeling* (pp. 327–341). Singapore: Springer.

Fernández-Mesa, A., & Alegre, J. (2015). Entrepreneurial orientation and export intensity: Examining the interplay of organizational learning and innovation. *International Business Review*, *24*(1), 148–156.

Fernando, Y., Jabbour, C. J. C., & Wah, W. X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: Does service capability matter? *Resources, Conservation and Recycling, 141*(2), 8–20.

Fujii, H., Iwata, K., Kaneko, S., & Managi, S. (2013). Corporate environmental and economic performance of japanese manufacturing firms: Empirical study for sustainable development. *Business Strategy and the Environment*, *22*(3), 187–201.

Games, D., & Rendi, R. P. (2019). The effects of knowledge management and risk taking on SME financial performance in creative industries in an emerging market: The mediating effect of innovation outcomes. *Journal of Global Entrepreneurship Research*, *9*(1), 1–14.

García-Pozo, A., Sánchez-Ollero, J. L., & Ons-Cappa, M. (2016). ECO-innovation and economic crisis: A comparative analysis of environmental good practices and labour productivity in the Spanish hotel industry. *Journal of Cleaner Production*, *138*(2), 131–138.

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The circular economy—A new sustainability paradigm? *Journal of Cleaner Production*, *143*(2), 757–768.

Gökgöz, F., & Yalçın, E. (2021). Investigating the environmental and economic performances of energy sector in OECD countries via MCDM approaches. In *Sustaining tomorrow* (pp. 65–92). Cham: Springer.

Gou, X., Xu, Z., & Herrera, F. (2018). Consensus reaching process for large-scale group decision making with double hierarchy hesitant fuzzy linguistic preference relations. *Knowledge-Based Systems*, *157*(12), 20–33.

Gupta, H., & Barua, M. K. (2017). Supplier selection among SMEs on the basis of their green innovation ability using BWM and fuzzy TOPSIS. *Journal of Cleaner Production*, *152*(2), 242–258.

Halila, F., & Rundquist, J. (2011). The development and market success of eco-innovations: A comparative study of eco-innovations and "other" innovations in Sweden. *European Journal of Innovation Management*, *14*(3), 278–302.

Hannen, J., Antons, D., Piller, F., Salge, T. O., Coltman, T., & Devinney, T. M. (2019). Containing the not-invented-here syndrome in external knowledge absorption and open innovation: The role of indirect countermeasures. *Research Policy*, *48*(9), 1–17.

Hansen, M. H., Li, H., & Svarverud, R. (2018). Ecological civilization: Interpreting the chinese past, projecting the global future. *Global Environmental Change*, *53*(2), 195–203.

Haskell, L., Bonnedahl, K. J., & Stål, H. I. (2021). Social innovation related to ecological crises: A systematic literature review and a research agenda for strong sustainability. *Journal of Cleaner Production*, *325*, 129316.

Hellström, T. (2007). Dimensions of environmentally sustainable innovation: The structure of eco-innovation concepts. *Sustainable Development*, *15*(3), 148–159.

Hildebrandt, J., Thrän, D., & Bezama, A. (2021). The circularity of potential bio-textile production routes: Comparing life cycle impacts of bio-based materials used within the manufacturing of selected leather substitutes. *Journal of Cleaner Production*, *287*(2), 125470.

Hitchcock, D., & Willard, M. (2012). *The step-by-step guide to sustainability planning: How to create and implement sustainability plans in any business or organization*. Routledge.

Hodgson, N., Buselich, K., & Halpin, D. (2005). The WA collaboration: Facilitating integration of sustainability issues in a community and civil society context. *Australasian Journal of Environmental Management*, *12*(sup1), 20–28.

Hojnik, J., & Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature. *Environmental Innovation and Societal Transitions*, *19*(12), 31–41.

Hojnik, J., Ruzzier, M., & Manolova, T. S. (2018). Internationalization and economic performance: The mediating role of eco-innovation. *Journal of Cleaner Production*, *17*(2)1), 1312–1323.

Holsapple, C. W., & Sena, M. P. (2005). ERP plans and decision-support benefits. *Decision Support Systems*, *38*(4), 575–590.

Horbach, J. (2014). Do eco-innovations need specific regional characteristics? An econometric analysis for Germany. *Review of Regional Research*, *34*(1), 23–38.

Huang, X., Iun, J., Liu, A., & Gong, Y. (2010). Does participative leadership enhance work performance by inducing empowerment or trust? The differential effects on managerial and non-managerial subordinates. *Journal of Organizational Behavior*, *31*(12), 122–143.

Huybrechts, J., Voordeckers, W., & Lybaert, N. (2013). Entrepreneurial risk taking of private family firms: The influence of a nonfamily CEO and the moderating effect of CEO tenure. *Family Business Review*, *26*(2), 161–179.

Ibrahim, Y. M., Hami, N., & Abdulameer, S. S. (2020). Assessing sustainable manufacturing practices and sustainability performance among oil and gas industry in Iraq. *International Journal of Energy Economics and Policy*, *10*(4), 60–67.

Ighravwe, D. E., Babatunde, M. O., Mosetlhe, T. C., Aikhuele, D., & Akinyele, D. (2022). A MCDM-based framework for the selection of renewable energy system simulation tool for teaching and learning at university level. *Environment Development and Sustainability*, *24*(11), 13035–13056.

Ishfaq, S., Ali, S., & Ali, Y. (2018). Selection of optimum renewable energy source for energy sector in Pakistan by using MCDM approach. *Process Integration and Optimization for Sustainability*, *2*(1), 61–71.

Jabbour, C. J. C., Seuring, S., de Sousa Jabbour, A. B. L., Jugend, D., Fiorini, P. D. C., Latan, H., & Izeppi, W. C. (2020). Stakeholders, innovative business models for the circular economy and sustainable performance of firms in an emerging economy facing institutional voids. *Journal of environmental management*, *264*(2), 1–20.

Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2005). A tale of two market failures: Technology and environmental policy. *Ecological economics*, *54*(2–3), 164–174.

John, K., Litov, L., & Yeung, B. (2008). Corporate governance and risk-taking. *The Journal of Finance*, *63*(4), 1679–1728.

Jyoti, J., & Rani, A. (2017). High performance work system and organisational performance: Role of knowledge management. *Personnel Review*, *46*(8), 1770–1795.

Kanger, L., & Schot, J. (2019). Deep transitions: Theorizing the long-term patterns of socio-technical change. *Environmental Innovation and Societal Transitions*, *32*(9), 7–21.

Karakaya, E., Hidalgo, A., & Nuur, C. (2014). Diffusion of eco-innovations: A review. *Renewable and Sustainable Energy Reviews*, *33*(2), 392–399.

Kazancoglu, Y., Ozkan-Ozen, Y. D., Mangla, S. K., & Ram, M. (2020). Risk assessment for sustainability in e-waste recycling in circular economy. *Clean Technologies and Environmental Policy*, *1*(13), 1145–1157.

Kemp, R., & Oltra, V. (2011). Research insights and challenges on eco-innovation dynamics. *Industry and Innovation*, *18*(03), 249–253.

Kemp, R., & Pearson, P. (2007). *Final report MEI project about measuring eco-innovation* (Vol. 10, pp. 1–120). Maastricht: UM Merit.

Kemp, R., & Pontoglio, S. (2011). The innovation effects of environmental policy instruments—A typical case of the blind men and the elephant? *Ecological Economics*, *72*(2), 28–36.

Kempers, M., Leitterstorf, M. P., & Kammerlander, N. (2019). *Risk behavior of family firms: A literature review, framework, and research agenda* (pp. 431–460). The Palgrave Handbook of Heterogeneity Among Family Firms.

Kesidou, E., & Demirel, P. (2012). On the drivers of eco-innovations: Empirical evidence from the UK. *Research Policy*, *41*(5), 862–870.

Khaw, K. W., Alnoor, A., Al-Abrrow, H., Chew, X., Sadaa, A. M., Abbas, S., & Khattak, Z. Z. (2022b). Modelling and evaluating trust in mobile commerce: A hybrid three stage fuzzy Delphi, structural equation modeling, and neural network approach. *International Journal of Human–Computer Interaction Article* , *38*(16), 1529–1545.

Khaw, K. W., Alnoor, A., Al-Abrrow, H., Tiberius, V., Ganesan, Y., & Atshan, N. A. (2022a). *Reactions towards organizational change: A systematic literature review* (pp. 1–24). Current Psychology, Article in Press.

Khaw, K. W., Thurasamy, R., Al-Abrrow, H., Alnoor, A., Tiberius, V., Abdullah, H. O., & Abbas, S. (2021). Influence of generational status on immigrants' entrepreneurial intentions to start new ventures: A framework based on structural equation modeling and multicriteria decision-making. *Journal of Entrepreneurship in Emerging Economies*.

Kiefer, C. P., Carrillo-Hermosilla, J., Río, D., P., & Barroso, F. J. C. (2017). Diversity of eco-innovations: A quantitative approach. *Journal of Cleaner Production*, *166*(2), 1494–1506.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, *150*(2), 264–272.

Koumparou, D. (2017). Circular economy and social sustainability. In *Proceedings of the Solid Waste Management & its Contribution to Circular Economy*, Athens, Greece, pp. 14–15.

Kravchenko, M., Pigosso, D. C., & McAloone, T. C. (2019). Towards the ex-ante sustainability screening of circular economy initiatives in manufacturing companies: Consolidation of leading sustainability-related performance indicators. *Journal of Cleaner Production, 241*, 1–19.

Kristoffersen, E., Blomsma, F., Mikalef, P., & Li, J. (2020). The smart circular economy: A digital-enabled circular strategies framework for manufacturing companies. *Journal of Business Research*, *120*(2), 241–261.

Kruggel, A., Tiberius, V., & Fabro, M. (2020). Corporate citizenship: Structuring the research field. *Sustainability*, *12*(13), 5289.

Kumar, A., Holuszko, M., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation And Recycling*, *122*(12), 32–42.

Kunz, N., Mayers, K., & Van Wassenhove, L. N. (2018). Stakeholder views on extended producer responsibility and the circular economy. *California Management Review*, *60*(3), 45–70.

Larbi-Siaw, O., Xuhua, H., Owusu, E., Owusu-Agyeman, A., Fulgence, B. E., & Frimpong, S. A. (2022). Eco-innovation, sustainable business performance and market turbulence moderation in emerging economies. *Technology in Society*, *68*(2), 1–15.

Lee, R. P., & Grewal, R. (2004). Strategic responses to new technologies and their impact on firm performance. *Journal of Marketing*, *68*(4), 157–171.

Leta, S. D., & Chan, I. C. C. (2021). Learn from the past and prepare for the future: A critical assessment of crisis management research in hospitality. *International Journal of Hospitality Management*, *95*(5), 1–11.

Lew, S., Tan, G. W. H., Loh, X. M., Hew, J. J., & Ooi, K. B. (2020). The disruptive mobile wallet in the hospitality industry: An extended mobile technology acceptance model. *Technology in Society*, *63*(2), 101430.

Li, K., Fang, L., & He, L. (2019). How population and energy price affect China's environmental pollution? *Energy Policy*, *129*(2), 386–396.

Lichtenthaler, U. (2011). The evolution of technology licensing management: Identifying five strategic approaches. *R&D Management*, *41*(2), 173–189.

Linder, M., & Williander, M. (2017). Circular business model innovation: Inherent uncertainties. *Business Strategy and the Environment*, *26*(2), 182–196.

Liu, Y., Wood, L. C., Venkatesh, V. G., Zhang, A., & Farooque, M. (2021). Barriers to sustainable food consumption and production in China: A fuzzy DEMATEL analysis from a circular economy perspective. *Sustainable Production and Consumption*, *28*, 1114–1129.

Magon, R. B., Thomé, A. M. T., Ferrer, A. L. C., & Scavarda, L. F. (2018). Sustainability and performance in operations management research. *Journal of Cleaner Production*, *190*(2), 104–117.

Mahmoudi, A., & Javed, S. A. (2022). Probabilistic approach to multi-stage supplier evaluation: Confidence level measurement in ordinal priority approach. *Group Decision and Negotiation*, *31*(5), 1051–1096.

Mahmoudi, A., Abbasi, M., & Deng, X. (2022a). A novel project portfolio selection framework towards organizational resilience: Robust ordinal priority approach. *Expert Systems with Applications*, *188*, 116067.

Mahmoudi, A., Abbasi, M., & Deng, X. (2022b). Evaluating the performance of the suppliers using hybrid DEA-OPA model: A sustainable development perspective. *Group Decision and Negotiation*, *31*(2), 335–362.

Mahmoudi, A., Deng, X., Javed, S. A., & Yuan, J. (2021a). Large-scale multiple criteria decision-making with missing values: Project selection through TOPSIS-OPA. *Journal of Ambient Intelligence and Humanized Computing*, *12*(10), 9341–9362.

Mahmoudi, A., Deng, X., Javed, S. A., & Zhang, N. (2021b). Sustainable supplier selection in megaprojects: Grey ordinal priority approach. *Business Strategy and the Environment*, *30*(1), 318–339.

Mahmoudi, A., Javed, S. A., & Mardani, A. (2022c). Gresilient supplier selection through fuzzy ordinal priority approach: Decision-making in post-COVID era. *Operations Management Research*, *15*(1), 208–232.

Mangla, S. K., Kusi-Sarpong, S., Luthra, S., Bai, C., Jakhar, S. K., & Khan, S. A. (2020). Operational excellence for improving sustainable supply chain performance. *Resources, Conservation, and Recycling, 162*(2), 1–17.

Manickam, P., & Duraisamy, G. (2019). 3Rs and circular economy. In *Circular economy in textiles and Apparel* (pp. 77–93). Woodhead Publishing.

Mannan, M., Al-Ansari, T., Mackey, H. R., & Al-Ghamdi, S. G. (2018). Quantifying the energy, water and food nexus: A review of the latest developments based on life-cycle assessment. *Journal of Cleaner Production*, *193*(2), 300–314.

Manzini, R., Lazzarotti, V., & Pellegrini, L. (2017). How to remain as closed as possible in the open innovation era: The case of Lindt & Sprüngli. *Long Range planning*, *50*(2), 260–281.

March, J. G. (1997). Understanding how decisions happen in organizations. *Organizational Decision Making*, *10*(2), 9–32.

Maroušek, J., Hašková, S., Zeman, R., & Vaníčková, R. (2015). Managerial preferences in relation to financial indicators regarding the mitigation of global change. *Science and Engineering Ethics*, *21*(1), 203–207.

Mathews, J. A., & Tan, H. (2016). Circular economy: Lessons from China. *Nature*, *531*(7595), 440–442.

Meng, Y., Yang, Y., Chung, H., Lee, P. H., & Shao, C. (2018). Enhancing sustainability and energy efficiency in smart factories: A review. *Sustainability*, *10*(12), 47–79.

Modgil, S., Gupta, S., Sivarajah, U., & Bhushan, B. (2021). Big data-enabled large-scale group decision making for circular economy: An emerging market context. *Technological Forecasting and Social Change*, *166*(12), 120607.

Monk, A., & Perkins, R. (2020). What explains the emergence and diffusion of green bonds? *Energy Policy*, *145*(2), 111641.

Morseletto, P. (2020). Targets for a circular economy. *Resources Conservation and Recycling*, *153*(2), 1–12.

Öcal, E., Oral, E. L., & Erdis, E. (2006). Crisis management in turkish construction industry. *Building and Environment*, *41*(11), 1498–1503.

Oliva, F. L., Teberga, P. M. F., Testi, L. I. O., Kotabe, M., Giudice, D., Kelle, M., P., & Cunha, M. P. (2022). Risks and critical success factors in the internationalization of born global startups of industry 4.0: A social, environmental, economic, and institutional analysis. *Technological Forecasting and Social Change*, *175*(2), 1–22.

Olsson, P., Galaz, V., & Boonstra, W. J. (2014). Sustainability transformations: A resilience perspective. *Ecology and Society*, *19*(4), 1-19.

Ooi, P. B., Ong, D. L. T., Peh, S. C., Ismail, S. F., Paramanathan, S. A. M. S., Lee, A. S. H., & Chan, N. N. (2021). Active aging, psychological well-being and quality of life of elderly and pre-elderly Malaysians during movement control periods. *Educational Gerontology*, *47*(8), 353–368.

Opricovic, S., & Tzeng, G. H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research*, *156*(2), 445–455.

Opricovic, S., & Tzeng, G. H. (2007). Extended VIKOR method in comparison with outranking methods. *European Journal of Operational Research*, *178*(2), 514–529.

Paladugula, A. L., Kholod, N., Chaturvedi, V., Ghosh, P. P., Pal, S., Clarke, L., & Wilson, S. A. (2018). A multi-model assessment of energy and emissions for India's transportation sector through 2050. *Energy Policy*, *116*(2), 10–18.

Palomares, I., Martinez, L., & Herrera, F. (2013). A consensus model to detect and manage noncooperative behaviors in large-scale group decision making. *IEEE Trans Fuzzy Systems*, *22*(3), 516–530.

Panno, A., Theodorou, A., Carbone, G. A., De Longis, E., Massullo, C., Cepale, G., & Sanesi, G. (2021). Go greener, less risk: Access to Nature is Associated with Lower Risk taking in different domains during the COVID-19 Lockdown. *Sustainability*, *13*(19), 10807.

Patwa, N., Sivarajah, U., Seetharaman, A., Sarkar, S., Maiti, K., & Hingorani, K. (2021). Towards a circular economy: An emerging economies context. *Journal of Business Research*, *122*(2), 725–735.

Pearson, C. M., & Clair, J. A. (1998). Reframing crisis management. *Academy of management review, 23*(1), 59–76.

Pieroni, M. P., McAloone, T. C., & Pigosso, D. C. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of cleaner production*, *215*(12), 198–216.

Pisano, G. P. (2015). You need an innovation strategy. *Harvard Business Review*, *93*(6), 44–54.

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.

Ramkumar, S., Mueller, M., Pyka, A., & Squazzoni, F. (2022). Diffusion of eco-innovation through interfirm network targeting: An agent-based model. *Journal of Cleaner Production*, *335*(2), 1–18.

Rasoolimanesh, S. M., Seyfi, S., Rastegar, R., & Hall, C. M. (2021). Destination image during the COVID-19 pandemic and future travel behavior: The moderating role of past experience. *Journal of Destination Marketing & Management*, *21*(9), 1–11.

Reike, D., Vermeulen, W. J., & Witjes, S. (2018). The circular economy: New or refurbished as CE 3.0? Exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. *Resources Conservation and Recycling*, *135*(12), 246–264.
Rennings, K. (2000). Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecological Economics*, *32*(2), 319–332.
Rezaei, J. (2015). Best-worst multi-criteria decision-making method. *Omega*, *53*(2), 49–57.
Rezaei, J. (2016). Best-worst multi-criteria decision-making method: Some properties and a linear model. *Omega*, *64*(2), 126–130.
Ripanti, E. F., & Tjahjono, B. (2019). Unveiling the potentials of circular economy values in logistics and supply chain management. *The International Journal of Logistics Management*, *30*(3), 723–742.
Ritchie, B. W. (2004). Chaos, crises and disasters: A strategic approach to crisis management in the tourism industry. *Tourism Management*, *25*(6), 669–683.
Ritzén, S., & Sandström, G. (2017). Barriers to the circular economy–integration of perspectives and domains. *Procedia Cirp*, *64*(2), 7–12.
Rogers, E. M. (2004). A prospective and retrospective look at the diffusion model. *Journal of Health Communication*, *9*(S1), 13–19.
Rosales-Calderon, O., & Arantes, V. (2019). A review on commercial-scale high-value products that can be produced alongside cellulosic ethanol. *Biotechnology for biofuels, 12*, 1–58.
Sadaa, A. M., Ganesan, Y., Khaw, K. W., Alnoor, A., Abbas, S., Chew, X., et al. (2022). Based on the perception of ethics in social commerce platforms: Adopting SEM and MCDM approaches for benchmarking customers in rural communities. *Current Psychology*, 1–35.
Sadeghi, M., Mahmoudi, A., Deng, X., & Luo, X. (2022). Prioritizing requirements for implementing blockchain technology in construction supply chain based on circular economy: Fuzzy ordinal priority approach.International Journal of Environmental Science and Technology,1–22.
Salih, M. M., Zaidan, B. B., & Zaidan, A. A. (2020). Fuzzy decision by opinion score method. *Applied Soft Computing*, *96*, 106595.
Salunke, S., Weerawardena, J., & McColl-Kennedy, J. R. (2011). Towards a model of dynamic capabilities in innovation-based competitive strategy: Insights from project-oriented service firms. *Industrial Marketing Management*, *40*(8), 1251–1263.
Sánchez, G., & Aznar, R. (2015). Evaluation of natural compounds of plant origin for inactivation of enteric viruses. *Food and Environmental Virology*, *7*(2), 183–187.
Sandberg, H., Alnoor, A., & Tiberius, V. (2022). Environmental, Social, and Governance ratings and financial performance: Evidence from the European food industry. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.3259.
Santacruz, L. (2020). Measures of firm risk-taking: Revisiting Bowman's paradox. *Managerial Finance*, *46*(3), 421–434.
Santoyo-Castelazo, E., & Azapagic, A. (2014). Sustainability assessment of energy systems: Integrating environmental, economic and social aspects. *Journal of Cleaner Production*, *80*(10), 119–138.
Saraswat, S. K., & Digalwar, A. K. (2021). Evaluation of energy alternatives for sustainable development of energy sector in India: An integrated Shannon's entropy fuzzy multi-criteria decision approach. *Renewable Energy*, *171*, 58–74.
Sariatli, F. (2017). Linear economy versus circular economy: A comparative and analyzer study for optimization of economy for sustainability. *Visegrad Journal on Bioeconomy and Sustainable Development*, *6*(1), 31–34.
Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development*, *17*(2), 48–56.
Schaltegger, S., Beckmann, M., & Hansen, E. G. (2013). Transdisciplinarity in corporate sustainability: Mapping the field. *Business Strategy and the Environment*, *22*(4), 219–229.
Schroll, A., & Mild, A. (2011). Open innovation modes and the role of internal R&D: An empirical study on open innovation adoption in Europe. *European Journal of Innovation Management*, *14*(4), 475–495.
Scott-Ladd, B., & Chan, C. C. (2004). Emotional intelligence and participation in decision-making: Strategies for promoting organizational learning and change. *Strategic Change*, *13*(2), 95–105.
Searcy, C. (2011). Updating corporate sustainability performance measurement systems. *Measuring Business Excellence*, *15*(2), 44–56.
Shen, B., Liu, S., Zhang, T., & Choi, T. M. (2019). Optimal advertising and pricing for new green products in the circular economy. *Journal of Cleaner Production*, *233*(12), 314–327.

Shi, L., Yin, Y., Zhang, L. C., Wang, S., Sillanpää, M., & Sun, H. (2019). Design and engineering heterojunctions for the photoelectrochemical monitoring of environmental pollutants: A review. *Applied Catalysis B: Environmental*, *248*(2), 405–422.

Shojaie, A. A., Babaie, S., Sayah, E., & Mohammaditabar, D. (2018). Analysis and prioritization of green health suppliers using fuzzy ELECTRE method with a case study. *Global Journal of Flexible Systems Management*, *19*(1), 39–52.

Singh Sandhawalia, B., & Dalcher, D. (2011). Developing knowledge management capabilities: A structured approach. *Journal of Knowledge Management*, *15*(2), 313–328.

Singh, J. S., Kumar, A., & Singh, M. (2019). Cyanobacteria: A sustainable and commercial bio-resource in production of bio-fertilizer and bio-fuel from waste waters. *Environmental and Sustainability Indicators*, *3*(12), 1–8.

Sinkula, J.M. (2002), "Market-based success, organizational routines, and unlearning", Journal of Business & Industrial Marketing, Vol. 17 No. 4, pp. 253–269.

Smerecnik, K. R., & Andersen, P. A. (2011). The diffusion of environmental sustainability innovations in north American hotels and ski resorts. *Journal of Sustainable Tourism*, *19*(2), 171–196.

Smith, W. K., & Tushman, M. L. (2005). Managing strategic contradictions: A top management model for managing innovation streams. *Organization Science*, *16*(5), 522–536.

Somech, A. (2010). Participative decision making in schools: A mediating-moderating analytical framework for understanding school and teacher outcomes. *Educational Administration Quarterly*, *46*(2), 174–209.

Su, Z., Ahlstrom, D., Li, J., & Cheng, D. (2013). Knowledge creation capability, absorptive capacity, and product innovativeness. *R&D Management*, *43*(5), 473–485.

Tello, S. F., & Yoon, E. (2008). Examining drivers of sustainable innovation. *International Journal of Business Strategy*, *8*(3), 164–169.

Terouhid, S. A., & Ries, R. (2016). Organizational sustainability excellence of construction firms—A framework. *Journal of Modelling in Management*, *11*(4), 911–931.

Tian, G., Zhang, H., Feng, Y., Wang, D., Peng, Y., & Jia, H. (2018). Green decoration materials selection under interior environment characteristics: A grey-correlation based hybrid MCDM method. *Renewable and Sustainable Energy Reviews*, *81*(12), 682–692.

Tian, X. W., & Zhai, X. X. (2019). Employee involvement in decision-making: The more the better? *International Journal of Manpower, 40*(5), 768–782.

Tiberius, V., Stiller, L., & Dabić, M. (2021a). Sustainability beyond economic prosperity: Social microfoundations of dynamic capabilities in family businesses. *Technological Forecasting and Social Change*, *173*, 121093.

Tiberius, V., Schwarzer, H., & Roig-Dobón, S. (2021b). Radical innovations: Between established knowledge and future research opportunities. *Journal of Innovation & Knowledge, 6*(3), 145–153.

Toubes, D. R., Araújo Vila, N., & Fraiz Brea, J. A. (2021). Changes in consumption patterns and tourist promotion after the COVID-19 pandemic. *Journal of Theoretical and Applied Electronic Commerce Research*, *16*(5), 1332–1352.

Turunen, L. L. M., & Halme, M. (2021). Communicating actionable sustainability information to consumers: The Shades of Green instrument for fashion. *Journal of Cleaner Production*, *297*(5), 1–10.

Han, T. S., Hsu-Hsin, C., & Aihwa, C. (2010). Employee participation in decision making, psychological ownership and knowledge sharing: Mediating role of organizational commitment in taiwanese high-tech organizations. *The International Journal of Human Resource Management*, *21*(12), 2218–2233.

Unlu, M., Ergene, E., Unlu, G. V., Zeytinoglu, H. S., & Vural, N. (2010). Composition, antimicrobial activity and in vitro cytotoxicity of essential oil from *Cinnamomum zeylanicum* Blume (Lauraceae). *Food and Chemical Toxicology*, *48*(11), 3274–3280.

Wah, K. K., Omar, A. Z., Alnoor, A., & Alshamkhani, M. T. (2022). Technology application in tourism in Asia: Comprehensive science mapping analysis. In *Technology Application in Tourism in Asia* (pp. 53–66). Singapore: Springer.

Wang, M., Wang, G., Sun, Z., Zhang, Y., & Xu, D. (2019). Review of renewable energy-based hydrogen production processes for sustainable energy innovation. *Global Energy Interconnection*, *2*(5), 436–443.

Wu, Z., & Xu, J. (2018). A consensus model for large-scale group decision making with hesitant fuzzy information and changeable clusters. *Information Fusion*, *41*(2), 217–231.

Yang, Y., Guo, H., Chen, L., Liu, X., Gu, M., & Ke, X. (2019). Regional analysis of the green development level differences in Chinese mineral resource-based cities. *Resources Policy*, *61*(2), 261–272.

Ying, J., & Li-jun, Z. (2012). Study on green supply chain management based on circular economy. *Physics Procedia*, *25*(12), 1682–1688.
Zaidan, A. S., Khaw, K. W., & Alnoor, A. (2022). The influence of crisis management, risk-taking, and innovation in sustainability practices: Empirical evidence from Iraq. *Interdisciplinary Journal of Information Knowledge and Management*, *17*, 413–442.
Zhu, Q., Geng, Y., & Lai, K. H. (2010). Circular economy practices among chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. *Journal of Environmental Management*, *91*(6), 1324–1331.
Zhu, Z., & Matsuno, K. (2016). Entrepreneurial proclivity: Its environmental conditions and growth consequences. *Journal of Strategic Marketing*, *24*(1), 20–33.
Zink, T., & Geyer, R. (2017). Circular economy rebound. *Journal of Industrial Ecology*, *21*(3), 593–602.
Zink, T., & Geyer, R. (2019). Material recycling and the myth of landfill diversion. *Journal of Industrial Ecology*, *23*(3), 541–548.

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