

Cultivating sustainable innovation: The role of environmental leadership in improving innovation performance



Khalid H. Alshammari*

Department of Management and Information Systems, University of Ha'il, Ha'il, Saudi Arabia

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ABSTRACT

This study explores the complex connections between green innovation, environmental leadership, innovation climate, and innovation performance in organizations within Saudi Arabia's industrial sectors. The research aims to uncover the detailed interactions among these factors and highlight their importance in a region known for its environmental challenges and industrial significance. A detailed survey involving 251 participants was conducted, and the data was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The study investigates how innovation climate mediates the relationship between green innovation and innovation performance and how environmental leadership modifies this relationship. The findings emphasize the critical role of green innovation and show a positive link between innovation performance and innovation climate. Environmental leadership is identified as crucial in enhancing the positive effects of green innovation on performance. However, an unexpected negative relationship between innovation climate and innovation performance was found, indicating that more research is needed in this area. These results are significant for organizational leaders who are trying to manage sustainability, leadership, and innovation amidst changing environmental and economic conditions.

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1. Introduction

Growing concern for the environment and an increasing need for ongoing innovation have made green innovation a priority for businesses worldwide. This study investigates the complex relationships of green innovation, environmental leadership, innovation climate, and innovation performance in the context of organizations operating in industrial sectors in Saudi Arabia. Given the sector's environmental footprint and vital significance in the region's economic landscape, this geographical and industrial focus is critical (Abubakar and Alshammari, 2023). In light of the serious environmental problems facing the world (Lapologang and Zhao, 2023; Lu et al., 2022), this study looks at how these organizations balance sustainability and innovation to stay ahead of the

competition while also taking care of important environmental issues.

This study investigates a group of important variables. To begin with, green innovation refers to a range of techniques that prioritize sustainability and promote environmental responsibility and resource efficiency (Ceptureanu et al., 2020). A substantial body of literature indicates that innovation initiatives have an essential role in driving organizational performance, encompassing advancements in both product and process innovation (Lapologang and Zhao, 2023; Srisathan et al., 2023). On the other side, environmental leadership relies on the forward momentum of organizational leaders to advance sustainability goals (Tu et al., 2023). The literature emphasizes the significant impact of leadership on the development of green innovation strategies and the overall performance of organizations (Ruiz-Mallén and Heras, 2020; Tu et al., 2023). Moreover, the concept of innovation climate refers to the dominant organizational environment, which is distinguished by elements such as receptiveness to novel concepts and a culture of collaboration (Simões et al., 2020). The literature emphasizes the significance of a positive innovation climate in facilitating innovation endeavors (Iqbal et al., 2021; Li and Qamruzzaman,

* Corresponding Author.

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Corresponding author's ORCID profile:

<https://orcid.org/0000-0002-6533-9377>

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2023). The relationship between green innovation, environmental leadership, and innovation climate has major significance in the context of firms in the region that operate in industries with significant environmental impacts. These sectors are critical to the region's economic development, but they also have a substantial environmental impact (Heim et al., 2023). The literature emphasizes that fostering green innovation practices in such industries is vital not only for addressing ecological concerns but also for ensuring long-term viability and competitiveness (Simões et al., 2020). Organizations can improve their innovation performance by including sustainability-driven innovation in their strategy. This allows them to not only lower their environmental impact but also meet the growing demand for eco-friendly products and services (Ceptureanu et al., 2020). Furthermore, the significance of environmental leadership becomes pronounced in this context (Tu et al., 2023). Leaders of organizations have to deal with the complicated world of sustainability rules, stakeholder demands, and limited resources. According to the literature, visionary leaders who promote sustainability efforts can foster a culture of creativity and environmental responsibility within their firms (Ruiz-Mallén and Heras, 2020; Tu et al., 2023). This leadership commitment can motivate employees to embrace green innovation and create a sustainable work environment. Therefore, it is important to understand and take advantage of these relationships for the benefit of individual organizations as well as the region's overall ecological and economic viability (Aminpour et al., 2020)

While the existing literature provides valuable insights into the relationships among green innovation, environmental leadership, innovation climate, and innovation performance, it also reveals notable gaps that warrant focused investigation within the specific context of the region. The literature highlights the need for empirical research that dissects these relationships in detail within the industrial sector (e.g., oil, gas, electricity, minerals, and water desalination) of the region (Alrashoud, 2020; Montambault Trudelle, 2023). These gaps include a number of aspects. Firstly, the regional and sectoral context of Saudi Arabia introduces unique dynamics that may influence the relationships differently from what is observed in more generalized studies (Alotaibi et al., 2022). Understanding how the relationship among these variables functions in this specific context is vital for organizations seeking to tailor their sustainability-driven innovation strategies effectively. Secondly, the relationship between innovation climate and innovation performance has been predominantly studied in different contexts (Ali et al., 2021; Prajogo and Ahmed, 2006). Exploring this relationship within industries may reveal insights that align with or diverge from existing literature. Understanding the complexities of these relationships can help businesses to create a more innovative work

environment. Finally, while an earlier study recognizes the importance of environmental leadership, the extent to which leadership commitment influences green innovation and the innovation climate in Saudi Arabia remains unknown (Xu et al., 2022). Investigating the impact of leadership in this context can offer a clearer picture of how leaders can drive sustainability initiatives and shape organizational innovation efforts effectively. In essence, these identified research gaps necessitate a focused investigation to bridge the knowledge divide and provide region-specific insights that can guide organizations in the industrial sector toward sustainable and innovative practices.

The theoretical underpinning for this research draws upon organizational climate theory, which posits that the organizational climate, in this case, the innovation climate, can significantly impact organizational outcomes (Wiratama et al., 2021). This theory provides a robust framework for understanding how a supportive innovation climate mediates the relationship between green innovation and innovation performance (Alarcón and Baculima, 2023). Moreover, environmental leadership theory stresses the importance of visionary leaders in driving sustainability initiatives and amplifying their impact (Balabantaray, 2023). These theories provide the foundation for our research objectives, which seek to untangle the complex web of relationships among these variables and contribute to the theoretical and practical understanding of sustainability-driven innovation within this specific regional and industrial context (Sharr, 2023).

2. Literature review

The Kingdom of Saudi Arabia is well recognized for its massive oil reserves and economic reliance on the energy industry. However, as the rest of the globe shifts toward sustainability and preservation of the environment, Saudi Arabia has begun a transformation. Central to this transformation is the exploration of green innovation and its profound implications for innovation performance (Irfan et al., 2022). The literature describes it as the tale of a country using innovation to safeguard its economic destiny and adjusting to worldwide changes (Gianelli et al., 2021). The Saudi Vision 2030 is a prominent example of the ambitious government initiatives at the heart of Saudi Arabia's pursuit of green innovation (Amran et al., 2020). Launched in 2016, this ambitious roadmap outlines the nation's commitment to diversify its economy and foster sustainable practices (Sarwar, 2022). It is not merely a plan but a pledge to reduce its reliance on oil revenues and usher in a new era of prosperity. The initiatives encompass renewable energy projects, water conservation programs, and the nurturing of environmentally friendly industries (Almulhim and Abubakar, 2023). These government-led endeavors serve as a testament to Saudi Arabia's dedication to green innovation and its potential to elevate

innovation performance across sectors (Li and Qamruzzaman, 2023).

There are both obstacles and possibilities in Saudi Arabia's vision of green innovation (Irfan et al., 2022). The nation possesses considerable renewable energy resources, including sun-drenched deserts and expansive wind corridors. However, it is crucial to prioritize the resolution of infrastructure and regulatory barriers (Sarwar, 2022). Moreover, raising awareness and educating the populace about green technologies and sustainable practices remain ongoing tasks (Li and Qamruzzaman, 2023). However, these challenges are met with tremendous opportunities. The nation's ambitious goals, especially in the realm of renewable energy, present a vast landscape for innovation. Collaborations with international partners and technology transfer agreements open doors to rapid advancements in green innovation (Gianelli et al., 2021). In this transformation, environmental leadership emerges as a pivotal character. Effective leadership at both governmental and corporate levels has the power to set the tone for environmentally responsible practices (Amran et al., 2020). Leaders who champion sustainability, allocate resources for green research and development, and encourage the adoption of green technologies play a critical role (Sarwar, 2022). Their influence serves as a key moderator, enhancing the outcomes of green innovation initiatives. As they lead by example and prioritize sustainability, they catalyze innovation performance, steering Saudi Arabia toward a greener and more prosperous future (Balabantaray, 2023).

Throughout this process, several Saudi enterprises have embraced green innovation. Saudi Aramco, a global oil behemoth, is one such example, having invested heavily in green technologies and energy-efficient practices (Paramati et al., 2022). These investments reduce their environmental impact while also enhancing their overall inventive skills. Furthermore, the King Abdullah University of Science and Technology (KAUST) has developed as a significant hub for green research and innovation (Missimer et al., 2015). This statement stands as evidence of Saudi Arabia's dedication to fostering domestic expertise in green technology and making contributions to global progress (Al-Saleh and Vidican, 2013).

Looking ahead, the green innovation and innovation performance in Saudi Arabia holds a promising and significant future. Continued government support, the development of local talent in green technologies, and the nurturing of a culture of sustainability will be vital components. As the discussed literature unfolds, future research endeavors could delve deeper into the specific mechanisms through which environmental leadership influences the relationship between green innovation and innovation performance (Idrees et al., 2023; Zhang et al., 2023). The aforementioned findings will hold significant value for policymakers and corporate leaders in Saudi Arabia as they manage the trajectory toward a future characterized

by sustainability, innovation, and prosperity. Within the context of this developing narrative, Saudi Arabia assumes a role that extends beyond mere passivity as an observer of global sustainability trends. Instead, it actively assumes the role of a protagonist, actively embracing green innovation and utilizing it to reshape its economic narrative. By doing so, Saudi Arabia aims to ensure a more promising and environmentally conscious future for future generations.

2.1. Theory and hypotheses development

2.1.1. Organizational climate theory

Organizational climate theory is an important concept in organizational psychology because it explains the ways in which internal organizational dynamics influence employee behavior and productivity (Zhang et al., 2020). According to this theory, a company's culture is determined by its employees' shared values, norms, and normative expectations in the workplace (Beus et al., 2023). Employees' work habits, relationships with coworkers, and reactions to the workplace environment are all heavily influenced by their perceptions of the company's culture (Magill et al., 2020). Through the lens of Organizational Climate Theory, we may analyze how the culture of a company affects its propensity to encourage innovation, and in this case, green innovation, in areas like sustainability and environmentally friendly activities (Bibi et al., 2020). The climate of an organization is critical in fostering creativity and new ideas, which are needed to solve today's pressing problems in environmental sustainability (Zhang et al., 2020). Creating an innovation climate through green innovation strategies and actions is deeply rooted in Organizational Climate Theory (Shahzad et al., 2020). To establish such a climate, organizations must align their values and goals with sustainability and communicate this commitment effectively (Beus et al., 2023). This corresponds to the theory's emphasis on shared perceptions. When employees perceive a clear and consistent organizational commitment to green innovation, it sets the stage for an innovation-friendly climate (Bibi et al., 2020). Supportive leadership, another vital aspect of Organizational Climate Theory, holds immense importance in fostering green innovation. Leaders play a central role in shaping the organizational climate (Magill et al., 2020). Leaders who actively champion green innovation and sustainability initiatives inspire employees to follow suit. This aligns with the theory's idea that leadership behavior significantly influences the perceptions and attitudes of employees within the organization (Zhang et al., 2020).

Allocating resources and providing training in green innovation is in line with the concept of a supportive organizational climate (Shahzad et al., 2020). This theory suggests that a positive climate arises when employees feel adequately equipped

and competent to perform their tasks (Bibi et al., 2020). By investing in resources and training related to green innovation, organizations empower their workforce to engage in environmentally responsible practices and contribute to sustainability goals (Magill et al., 2020). Open communication channels are also a key factor influenced by Organizational Climate Theory. Effective communication fosters a sense of trust and collaboration among employees. In the context of green innovation, this is essential for sharing ideas and knowledge about sustainability initiatives (Beus et al., 2023). When employees feel comfortable sharing their perspectives and working together on innovative green projects, it reflects a climate of openness and collaboration (Magill et al., 2020). Recognition and rewards, an essential component of creating an innovation climate, align with the principles of Organizational Climate Theory (Shahzad et al., 2020). Recognizing and appreciating green innovation initiatives provides great reinforcement. According to the hypothesis, awards and recognition foster an environment of gratitude and can encourage employees to participate actively in sustainability activities (Bibi et al., 2020).

The relationship between the innovation climate, green innovation strategies, and innovation performance is a central theme in the context of Organizational Climate Theory (Magill et al., 2020). A conducive innovation climate enhances an organization's capacity to innovate, leading to improved innovation performance (Bibi et al., 2020). In terms of green innovation, this translates into advancements in both product and process innovation (Beus et al., 2023). Product innovation in a sustainable context involves the development of environmentally friendly products and services.

When an organization fosters an innovation climate that supports green initiatives, employees are more likely to generate creative solutions that align with sustainability goals (Bibi et al., 2020). This resonates with the theory's notion that organizational climate influences behavior, in this case, driving employees to innovate in sustainable product development. Process innovation, another dimension of innovation performance, is equally influenced by the innovation climate (Zhang et al., 2020). Organizations with a positive climate tend to seek innovative ways to reduce waste, conserve resources, and streamline operations. These process innovations enhance efficiency, reduce costs, and minimize the organization's environmental footprint, all of which are consistent with the theory's premise that organizational climate shapes behavior and performance (Shahzad et al., 2020).

Crucially, environmental leadership, which plays a central role in this narrative, aligns with Organizational Climate Theory's emphasis on leadership's impact on climate (Bibi et al., 2020). Leaders who champion sustainability and green innovation serve as role models, influencing the organizational climate positively. Their commitment and actions demonstrate that sustainability is a core organizational value, reinforcing its importance and

shaping the behavior of employees throughout the organization (Magill et al., 2020). In conclusion, organizational climate theory provides a comprehensive framework for understanding how an organization's climate influences its capacity to create an innovative climate through green innovation strategies and actions (Zhang et al., 2020). This, in turn, contributes to innovation performance in the form of both product and process innovation (Shahzad et al., 2020). Environmental leadership emerges as a critical aspect, consistent with the theory's emphasis on leadership's role in shaping the organizational climate. By embracing the principles of this theory, organizations can navigate the path toward sustainable innovation and enhanced performance (Beus et al., 2023).

2.1.2. Hypotheses development

Green innovation refers to the development and adoption of environmentally friendly technologies, processes, and practices within organizations (Huang et al., 2022). Literature on green innovation and its impact on innovation performance highlights the crucial role of sustainability in contemporary business environments (Abbas and Sağsan, 2019). Organizations are increasingly recognizing that integrating green innovation into their strategies not only helps meet environmental goals but also positively affects their overall innovation performance (Khan et al., 2023). Innovation performance encompasses the organization's ability to generate valuable innovations, including product and process innovations (Alrowwad et al., 2020).

Numerous studies have explored the relationship between green innovation and innovation performance (Khan et al., 2023). Researchers have investigated how organizations that invest in eco-friendly technologies and practices can simultaneously achieve enhanced innovation outcomes (Huang et al., 2022). These studies have employed various methodologies, including surveys, case studies, and longitudinal analyses, to understand the dynamics between green innovation and innovation performance (Alrowwad et al., 2020). Empirical research consistently indicates a positive relationship between green innovation and innovation performance (Abbas and Sağsan, 2019). Organizations that prioritize sustainability and invest in green R&D activities tend to demonstrate higher levels of innovation in both product and process domains (Khan et al., 2023). These findings underline the potential of green innovation as a driver of overall innovation performance (Huang et al., 2022). The importance of green innovation and its impact on innovation performance has gained widespread recognition in the literature. Scholars and practitioners alike acknowledge that sustainability-oriented innovation can lead to competitive advantages, market differentiation, and improved organizational resilience (Abbas and Sağsan, 2019). The literature highlights that these

variables are not merely peripheral considerations but integral to an organization's long-term success.

The empirical support for this hypothesis is substantial. Studies across various industries and regions consistently demonstrate that organizations embracing green innovation strategies experience a positive impact on their innovation performance metrics (Khan et al., 2023). This empirical evidence provides a strong foundation for hypothesizing a significant relationship between green innovation and innovation performance (Alrowwad et al., 2020). Organizational climate theory supports the development of this hypothesis by emphasizing the role of the organizational context in influencing behavior and performance (Shahzad et al., 2020). When an organization fosters a climate that encourages and supports green innovation, employees are more likely to engage in innovative practices that lead to enhanced innovation performance (Beus et al., 2023). This aligns with the theory's core tenets, emphasizing that shared perceptions and attitudes within an organization shape employees' actions and responses to the organizational context (Zhang et al., 2020). In the context of green innovation, a positive climate promotes innovation performance by encouraging environmentally sustainable practices and strategies (Magill et al., 2020).

H1: Green innovation significantly influences the innovation performance of organizations.

As previously defined, green innovation entails the development and implementation of environmentally friendly technology, processes, and practices inside enterprises (Huang et al., 2022). In the literature, the relationship between green innovation and the broader innovation climate is explored as organizations strive to create environments that nurture creativity, experimentation, and sustainability (Arici and Uysal, 2022). The debate centers on how embracing green innovation can influence the overall climate for innovation within organizations. Researchers have conducted empirical studies to investigate the impact of green innovation on the innovation climate (Abbas and Sağsan, 2019). These studies often employ surveys and organizational assessments to gauge employees' perceptions of the innovation climate and its alignment with sustainability and green initiatives (Alrowwad et al., 2020). Past research indicates that green innovation significantly influences the innovation climate of organizations (Huang et al., 2022). When organizations prioritize green innovation, it sends a signal to employees that sustainability and innovative thinking are valued. This, in turn, fosters a climate that is conducive to creativity, risk-taking, and experimentation, all of which are crucial for innovation (Arici and Uysal, 2022).

The importance of these variables in the literature is well-recognized (Abbas and Sağsan, 2019). Scholars emphasize that a positive innovation

climate is essential for driving innovation outcomes (Khan et al., 2023). Green innovation is seen as a catalyst that aligns sustainability goals with innovation efforts, ultimately shaping the innovation climate in a manner that encourages environmentally responsible and innovative practices (Magill et al., 2020). Empirical studies consistently support the hypothesis that green innovation significantly influences the innovation climate within organizations (Arici and Uysal, 2022). Employees in organizations that prioritize green innovation tend to perceive a more positive innovation climate characterized by a greater willingness to explore sustainable solutions and embrace innovative thinking (Faulks et al., 2021). Organizational Climate Theory supports this hypothesis by highlighting how shared perceptions within an organization shape the overall climate (Zhang et al., 2020). When green innovation is integrated into an organization's culture and practices, it influences employees' perceptions of the innovation climate (Shahzad et al., 2020). The theory underlines that a positive climate for green innovation encourages a broader culture of innovation, aligning with the core principles of Organizational Climate Theory (Beus et al., 2023).

H2: Green innovation significantly influences the innovation climate of organizations.

Empirical research investigating the relationship between innovation climate and innovation performance has been a focal point of academic inquiry (Faulks et al., 2021). Researchers have employed a variety of research methods to delve into this dynamic relationship, ranging from large-scale surveys and case studies to qualitative interviews and longitudinal analyses (Huang et al., 2022). They have examined how the presence or absence of a conducive innovation climate affects an organization's ability to innovate in terms of products and processes (Alrowwad et al., 2020). These studies have considered various industries, organizational sizes, and contexts to provide a comprehensive understanding of the relationships between these variables (Khan et al., 2023). Through rigorous empirical analysis, they have sought to elucidate whether an innovation-friendly climate is indeed a critical determinant of innovation performance, providing actionable insights for organizations seeking to enhance their innovative capabilities (Huang et al., 2022). The findings of past research consistently indicate a significant and positive relationship between innovation climate and innovation performance within organizations (Arici and Uysal, 2022). Organizations that foster a supportive innovation climate tend to exhibit higher levels of innovation performance in both product and process innovation (Abbas and Sağsan, 2019). These findings have been replicated across various sectors, suggesting that the presence of a positive climate for innovation is a robust predictor of an organization's capacity to generate valuable

innovations (Khan et al., 2023). Moreover, these studies often highlight the specific dimensions of the innovation climate, such as leadership support for innovation, clear communication of innovation goals, and an environment that encourages risk-taking and experimentation, as key drivers of enhanced innovation performance (Faulks et al., 2021).

The literature recognizes the vital importance of both innovation climate and innovation performance for organizations in today's dynamic and competitive business landscape (Le, 2022). An innovation-friendly climate is considered a catalyst for fostering a culture of creativity, adaptability, and resilience. It is viewed as a critical factor that enables organizations to respond effectively to changing market conditions and customer needs (Khan et al., 2023). Furthermore, innovation performance is acknowledged as a key driver of an organization's ability to maintain relevance and success (Abbas and Sağsan, 2019). Innovations in products and processes can lead to market differentiation, increased customer loyalty, and improved cost efficiency (Faulks et al., 2021). Therefore, the significance of these variables is deeply ingrained in the literature, as they are instrumental in determining an organization's ability to thrive in a rapidly evolving business environment (Le, 2022).

The empirical support for the development of the hypothesis is extensive and compelling. A plethora of empirical studies conducted across diverse industries and organizational settings consistently confirm the hypothesis that innovation climate significantly influences innovation performance (Alrowwad et al., 2020). These studies provide robust evidence that organizations with a conducive innovation climate tend to outperform their peers in terms of generating innovative products and processes (Le, 2022). The empirical support strengthens the hypothesis by demonstrating the practical and real-world implications of fostering an innovation-friendly environment within organizations. Organizational Climate Theory lends considerable support to the development of this hypothesis by underscoring the role of the organizational context in shaping employee attitudes, behaviors, and performance (Magill et al., 2020). The theory posits that shared perceptions and attitudes within an organization, represented by the innovation climate in this context, directly influence how employees respond to their work environment (Shahzad et al., 2020). A positive innovation climate aligns perfectly with the theory's core principles, fostering an environment that encourages innovative behaviors and attitudes among employees (Beus et al., 2023). In essence, Organizational Climate Theory provides a strong theoretical foundation for this hypothesis (Zhang et al., 2020) by highlighting the pivotal role of the organizational climate in driving employee actions and ultimately influencing innovation performance.

H3: Innovation climate significantly influences the innovation performance of organizations.

The literature extensively explores the relationship between green innovation and innovation performance, recognizing the positive impact of environmentally sustainable practices on an organization's capacity to innovate (Qu et al., 2022). This hypothesis introduces innovation climate as a mediating factor, suggesting that the relationship between green innovation and innovation performance is not direct but is instead transmitted through its influence on the organizational climate for innovation (Khan et al., 2023). The debate in the literature largely centers on the mechanisms through which innovation climate mediates this relationship and the extent to which it serves as a critical intermediary (Khan et al., 2023). Empirical research investigating the mediation effect of innovation climate in the relationship between green innovation and innovation performance has gained prominence (Le, 2022). Researchers have employed various research methodologies, including structural equation modeling, longitudinal analyses, and case studies, to explore the complex dynamics between these variables (Sahoo et al., 2023). These studies aim to uncover the underlying mechanisms by which innovation climate channels the impact of green innovation on innovation performance (Khan et al., 2023).

The findings of past research consistently affirm the mediation hypothesis, demonstrating that innovation climate significantly mediates the relationship between green innovation and innovation performance (Qu et al., 2022). Organizations that prioritize green innovation tend to foster a more supportive innovation climate characterized by a culture of sustainability, openness to new ideas, and a commitment to environmentally responsible practices (Sahoo et al., 2023). This conducive climate, in turn, amplifies the positive effects of green innovation on innovation performance, making it a well-supported and empirically validated proposition. The literature recognizes the critical importance of green innovation, innovation climate, and innovation performance individually. Green innovation is viewed as a strategic lever to align an organization's practices with environmental goals (Alrowwad et al., 2020). An innovation climate is seen as fundamental for nurturing a culture of creativity and adaptability. Innovation performance is acknowledged as a key driver of an organization's competitiveness and success (Khan et al., 2023). The significance of these variables collectively is well-established, and their interconnectedness is increasingly acknowledged as central to comprehending how organizations can thrive in a rapidly changing business landscape (Qu et al., 2022).

Empirical support for this hypothesis is robust, emanating from a burgeoning body of research. Studies consistently demonstrate the mediating role of innovation climate in the relationship between green innovation initiatives and innovation performance (Khan et al., 2023; Sahoo et al., 2023). By prioritizing green innovation, organizations not

only enhance innovation performance directly but also indirectly through the cultivation of a conducive innovation climate (Alrowwad et al., 2020). This empirical substantiation reinforces the hypothesis and emphasizes the practical importance of recognizing the intermediary role played by the organizational climate for innovation (Sahoo et al., 2023). Organizational Climate Theory offers theoretical support for this hypothesis by highlighting the influence of the organizational context, represented by the innovation climate, on employee behaviors and performance (Zhang et al., 2020). The theory posits that shared perceptions and attitudes within an organization shape how employees respond to their work environment (Beus et al., 2023). In this context, a positive innovation climate acts as a mediator that channels the impact of green innovation on innovation performance, aligning with the core tenets of Organizational Climate Theory (Shahzad et al., 2020). It emphasizes the pivotal role of the organizational climate in shaping employee actions and ultimately influencing innovation outcomes (Magill et al., 2020).

H4: Innovation climate significantly mediates the relationship between green innovation and innovation performance of organizations.

In the literature, the relationship between green innovation and innovation performance has been extensively explored, highlighting the positive impact of environmentally sustainable practices on an organization's capacity to innovate (Wang et al., 2022). This hypothesis introduces environmental leadership as a moderating factor, suggesting that the relationship between green innovation and innovation performance is influenced by the degree of commitment and support exhibited by organizational leaders for sustainability initiatives (Qu et al., 2022). The debate in the literature often revolves around the extent to which environmental leadership amplifies or mitigates the relationship between green innovation and innovation performance (Le, 2022). Empirical research examining the moderating effect of environmental leadership on the relationship between green innovation and innovation performance has gained prominence (Wang et al., 2022). Researchers have employed various research methodologies, including regression analyses, surveys, and case studies, to investigate how leadership behavior interacts with green innovation practices and their subsequent impact on innovation performance (Khan et al., 2023).

The findings of past research consistently support the hypothesis that environmental leadership significantly moderates the relationship between green innovation and innovation performance (Wang et al., 2022). Organizational leaders who actively champion sustainability initiatives and exhibit strong environmental leadership behaviors enhance the positive effects of

green innovation on innovation performance (Qu et al., 2022). Conversely, weak environmental leadership may diminish the impact of green innovation on innovation outcomes (Khan et al., 2023). These findings emphasize the crucial role played by leaders in shaping the sustainability trajectory and innovative capabilities of their organizations. The literature recognizes the significant importance of green innovation, environmental leadership, and innovation performance individually (Wang et al., 2022). Green innovation is viewed as a strategic tool to align an organization's practices with environmental goals (Aftab et al., 2022). Environmental leadership is seen as pivotal for setting the tone and direction of sustainability efforts. Innovation performance is acknowledged as a key driver of an organization's competitiveness and success (Khan et al., 2023). The significance of these variables collectively is well-established, and their interconnectedness is increasingly acknowledged as central to comprehending how organizations can excel in a rapidly changing business environment (Zhang and Ma, 2021).

Empirical support for this hypothesis is robust, stemming from a growing body of research (Fig. 1). Numerous studies consistently demonstrate that environmental leadership significantly moderates the relationship between green innovation and innovation performance (He et al., 2023). This empirical substantiation stresses the practical importance of recognizing the role of leaders in shaping the dynamics between green innovation practices and their impact on innovation outcomes (Zhang and Ma, 2021). It reinforces the notion that the influence of green innovation is not uniform across organizations and is contingent on the level of commitment and support exhibited by environmental leaders (Aftab et al., 2022). Organizational Climate Theory offers theoretical support for this hypothesis by emphasizing the role of leadership behavior in shaping the organizational context (Magill et al., 2020). Leaders, as part of the organizational climate, have a profound influence on employee attitudes, behaviors, and performance (Beus et al., 2023). Environmental leadership aligns with the core principles of Organizational Climate Theory, highlighting how leaders can moderate the relationship between green innovation practices and innovation performance (Shahzad et al., 2020). Leaders who actively champion sustainability initiatives shape the organizational climate in a way that amplifies the positive impact of green innovation on innovation outcomes, emphasizing the pivotal role of leadership in influencing innovation dynamics within organizations (Zhang et al., 2020).

H5: Environmental leadership significantly moderates the relationship between green innovation and innovation performance of organizations.

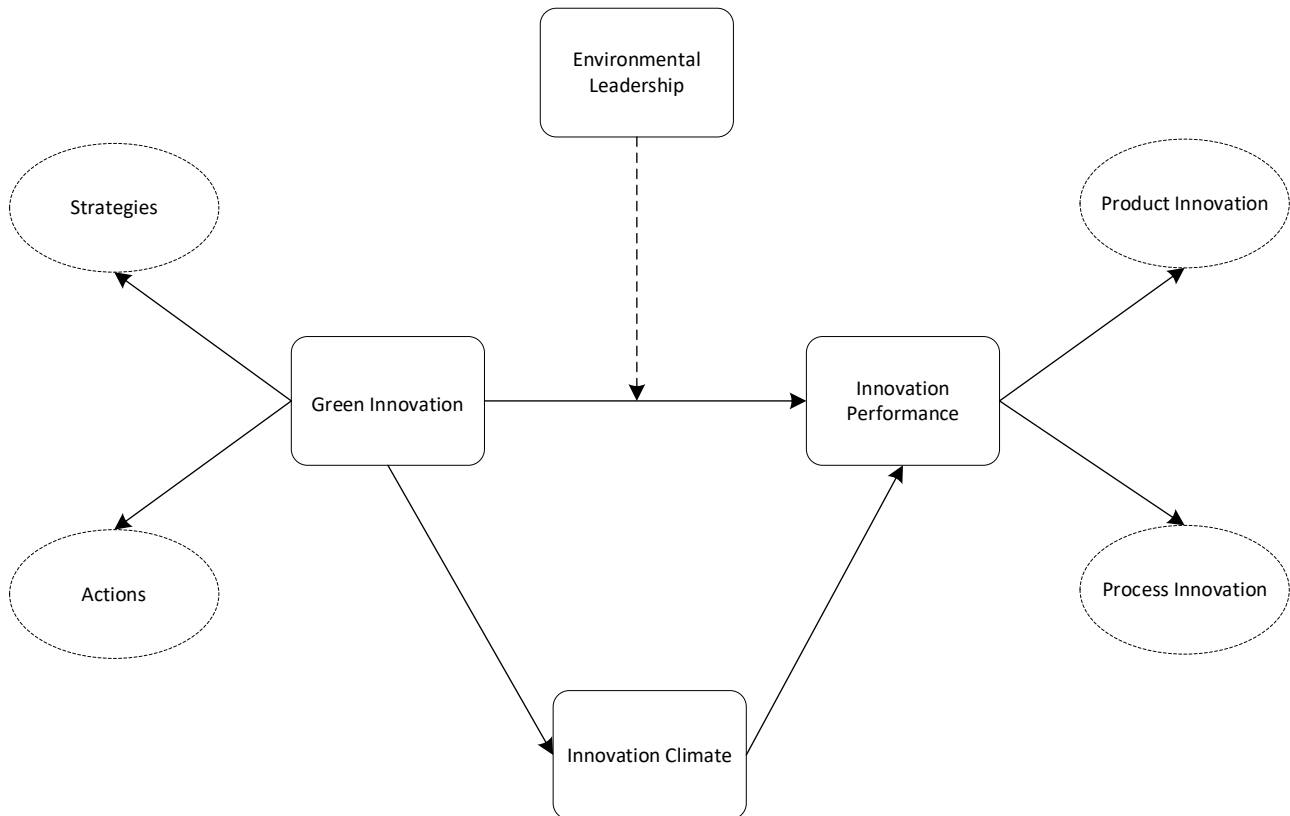


Fig. 1: Theoretical model

3. Methodology

This research aimed to investigate the relationship between green innovation, environmental leadership, innovation climate, and innovation performance within organizations operating in the industrial sectors in Saudi Arabia. The study utilized data from 251 participants employed in various roles within organizations in the industrial sectors. PLS-SEM was employed as the primary analytical technique to examine the proposed research model. Data for this research were gathered through a structured questionnaire designed to capture information related to the key variables of interest: green innovation, environmental leadership, innovation climate, and innovation performance.

The survey instrument consisted of multiple validated scales to measure the key constructs of green innovation, environmental leadership, innovation climate, and innovation performance. Participants were requested to respond to a series of statements on a Likert scale, reflecting their perceptions and experiences within their respective organizations. The survey also collected demographic information, such as participants' age, gender, years of experience, and organizational tenure.

The questionnaire was designed to capture relevant information on variables related to green innovation, innovation climate, innovation performance, and environmental leadership. It included established scales and items adapted from prior research to ensure content validity. To assess green innovation, the four questions from the scale

of Bahmani et al. (2023) are used. For measuring the innovation climate, the five items from the scale of Tan and Lee (2019) are used. To assess innovation performance (four items) and environmental leadership (five questions), the scale of Bahmani et al. (2023) is used. The data was collected through online surveys. PLS-SEM was employed to analyze the collected data. PLS-SEM is well-suited for research models involving multiple variables and complex relationships, making it an appropriate choice for examining the complex association between green innovation, environmental leadership, innovation climate, and innovation performance (Hair et al., 2014). This technique allowed for both the assessment of the measurement model's validity and reliability and the estimation of the structural relationships between the variables (Hair et al., 2019).

Data validation procedures were conducted to ensure the quality and accuracy of the collected data. These included checks for missing values, outliers, and response consistency. Additionally, the measurement scales used in the survey underwent rigorous testing for reliability and validity through established statistical methods, including Cronbach's alpha for internal consistency and confirmatory factor analysis for construct validity. The research model, which posited relationships between green innovation, environmental leadership, innovation climate, and innovation performance, was tested using PLS-SEM. This involved examining path coefficients, R-squared values, and bootstrapping techniques to assess the significance and strength of the hypothesized relationships within the model. The data analysis process aimed to provide insights

into the relationships between the studied variables and the role of environmental leadership and innovation climate in moderating and mediating these relationships. The findings were interpreted in the context of the research objectives and theoretical framework, contributing to a deeper understanding of the factors influencing innovation performance in environmentally sensitive industries.

4. Results

Table 1 presents Cronbach's alpha coefficients for each of the measurement constructs used in the study. These coefficients are a critical indicator of the internal consistency and reliability of the scales. For the "Actions" construct, Cronbach's alpha coefficient was calculated to be 0.718, signifying a moderate level of internal consistency. This suggests that the items measuring actions within the context of the study demonstrated a reasonable degree of reliability in capturing participants' responses. Notably, constructs such as "green innovation" and "innovation climate" exhibited higher levels of internal consistency with Cronbach's alpha coefficients of 0.822 and 0.845, respectively. These coefficients indicate that the items within these scales consistently and reliably measured the intended concepts. Conversely, constructs like "product innovation" and "actions" displayed slightly lower alpha coefficients, suggesting a somewhat lower level of internal consistency. Nevertheless, all the constructs exhibited acceptable levels of reliability, demonstrating the robustness of the measurement instruments employed in the study (Bartone et al., 2022; Ruel et al., 2021). These findings enhance confidence in the accuracy of the data collected and the subsequent analysis of the research model (Table 1).

	Cronbach's alpha
Actions	0.718
Environmental leadership	0.780
Green innovation	0.822
Innovation climate	0.845
Innovation performance	0.760
Process innovation	0.754
Product innovation	0.703
Strategies	0.795

Table 2 presents the factor loadings, composite reliability, and average variance extracted (AVE) for the key constructs in the study, offering insights into the measurement properties of the research model. For the "Green Innovation" construct, the factor loading was found to be 0.884, indicating a strong relationship between the observed indicators and the underlying construct. The composite reliability for this construct was 0.658, suggesting a satisfactory level of internal consistency. Additionally, the AVE for "Green Innovation" was 0.777, surpassing the recommended threshold of 0.5, signifying that a substantial proportion of the variance in the construct was captured by its indicators. In the case of "Actions," factor loadings for A1 and A2 were 0.848 and 0.914, respectively, demonstrating their strong association with the construct. The composite reliability for "Actions" was 0.874, indicating high internal consistency. The AVE for this construct was 0.777, exceeding the threshold for adequate convergence. For the "Strategies" construct, factor loadings for S1 and S2 were 0.852 and 0.897, respectively, demonstrating their strong relationship with the construct. The composite reliability for "Strategies" was 0.867, indicating robust internal consistency. The AVE for this construct was 0.765, surpassing the recommended threshold (Fig. 2).

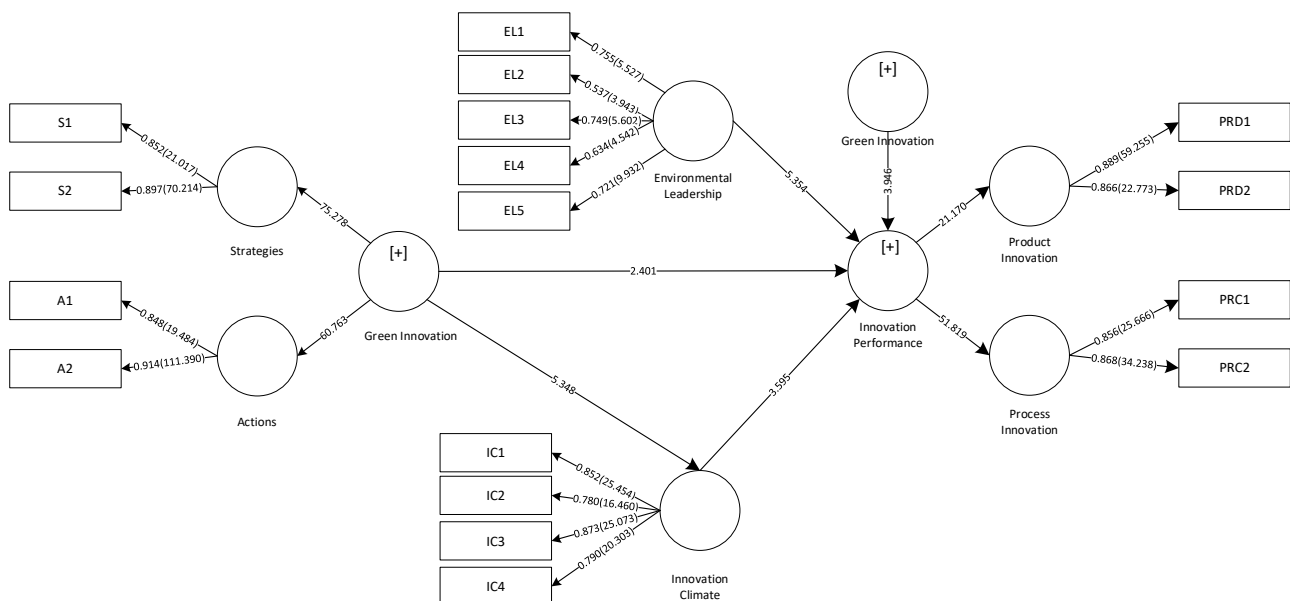


Fig. 2: Estimated model

For "Innovation Performance," the factor loading was 0.847, signifying a strong connection with the construct. However, the composite reliability for this

construct was 0.581, slightly lower than desired, suggesting the need for further evaluation. The AVE for "Innovation Performance" was 0.743, indicating

adequate convergence. Table 2 also provides similar measurement properties for the constructs of "Process Innovation," "Product Innovation," "Environmental Leadership," and "Innovation

Climate." These findings collectively contribute to the overall assessment of the reliability and validity (Kurdi et al., 2022) of the research model (Table 2).

Table 2: Factor loadings, composite reliability, and AVE

	Factors	Original sample	Composite reliability	AVE
Green innovation			0.884	0.658
	Actions	A1	0.848	0.874
Strategies		A2	0.914	
		S1	0.852	0.867
Innovation performance		S2	0.897	
			0.847	0.581
Process innovation		PRC1	0.856	0.853
		PRC2	0.868	
Product innovation		PRD1	0.889	0.870
		PRD2	0.866	
Environmental leadership		EL1	0.755	0.813
		EL2	0.537	
		EL3	0.749	
		EL4	0.634	
		EL5	0.721	
Innovation climate		IC1	0.852	0.895
		IC2	0.780	
		IC3	0.873	
		IC4	0.790	0.680

Table 3 presents the Fornell-Larcker Criterion, which is used to assess the discriminant validity of the measurement constructs. The values on the diagonal represent the square root of the AVE for each construct, while the off-diagonal values represent the correlations between constructs. This criterion aids in determining whether the constructs are sufficiently distinct from each other, indicating discriminant validity. For the "Environmental Leadership" construct, the square root of its AVE is 0.684. When compared to the correlations with other constructs, it is higher than the correlations with "Green Innovation" (0.533), "Innovation Climate" (0.640), and "Innovation Performance" (0.674), suggesting adequate discriminant validity. Similarly, for "Green Innovation," the square root of its AVE is 0.811. This value is higher than the correlations with "Environmental Leadership" (0.533) and "Innovation Climate" (0.452), confirming discriminant validity. For "Innovation Climate," the square root of its AVE is 0.825, which exceeds the correlations with both "Environmental Leadership" (0.640) and "Green Innovation" (0.452), supporting discriminant validity. Lastly, for "Innovation Performance," the square root of its AVE is 0.762. This value is higher than the correlations with "Environmental Leadership" (0.674), "Green Innovation" (0.592), and "Innovation Climate" (0.345), indicating that it also meets the criterion for discriminant validity. Overall, the Fornell-Larcker Criterion results provide evidence of discriminant validity (Yusoff et al., 2020), suggesting that the measurement constructs in the study are sufficiently distinct from each other, reinforcing the robustness of the research model (Table 3).

Table 4 presents the Heterotrait-Monotrait (HTMT) ratio, which is utilized to assess the discriminant validity of the measurement constructs. The HTMT ratio compares the correlations between constructs to the square root of the AVE for those constructs. A value below the threshold of 0.85 is typically considered indicative of acceptable discriminant validity. For the "Environmental Leadership" construct, the HTMT ratios with all other constructs are not presented in Table 4. However, to assess discriminant validity, it is essential to compare these ratios with the threshold of 0.85. If all HTMT ratios involving "Environmental Leadership" are below this threshold, it suggests acceptable discriminant validity. For "Green Innovation," the HTMT ratio with "Innovation Climate" is 0.529, which is below the threshold of 0.85, indicating acceptable discriminant validity. For "Innovation Climate," the HTMT ratios with "Environmental Leadership" and "Green Innovation" are 0.894 and 0.529, respectively. Both of these values fall below the 0.85 threshold, indicating acceptable discriminant validity. For "Innovation Performance," the HTMT ratios with "Environmental Leadership," "Green Innovation," and "Innovation Climate" are 0.627, 0.733, and 0.422, respectively. All of these ratios are below the 0.85 threshold, demonstrating that "Innovation Performance" also meets the criteria for acceptable discriminant validity. In summary, the HTMT ratios presented in Table 4 provide evidence of acceptable discriminant validity for all measurement constructs in the study (Afthanorhan et al. 2021), indicating that these constructs are distinct from each other as required by the research model (Table 4).

Table 3: Fornell-Larcker criterion

	1	2	3	4
Environmental leadership	0.684			
Green innovation	0.533	0.811		
Innovation climate	0.640	0.452	0.825	
Innovation performance	0.674	0.592	0.345	0.762

Table 4: HTMT

	1	2	3	4
Environmental leadership				
Green innovation	0.553			
Innovation climate	0.894	0.529		
Innovation performance	0.627	0.733	0.422	

Table 5 presents various model fitness indicators, which are essential for evaluating the performance of the research model. These indicators assess the model's ability to predict and explain the variance in the observed data. Q^2 Predict is a measure of the model's predictive relevance. In this context, it has a value of 0.760, indicating that the model can explain a substantial portion (76%) of the variance in the dependent variables. A higher Q^2 Predict value suggests that the model has good predictive power, which is a favorable outcome in empirical research. RMSE quantifies the average difference between the observed and predicted values in the model. In this case, the RMSE is 0.070, indicating that, on average, the model's predictions deviate by 0.070 units from the actual values. A lower RMSE value suggests that the model's predictions are closer to the observed data, signifying better model performance. MAE measures the average magnitude of errors between predicted and observed values. With a value of 0.081, the model's predictions, on average, deviate by 0.081 units from the actual values (**Table 5**). Similar to RMSE, a lower MAE value indicates better model accuracy, as smaller deviations imply a closer fit to the observed data. In summary, the results in **Table 5** indicate that the research model exhibits good predictive relevance (Q^2 Predict) with low levels of prediction error (RMSE and MAE). These findings suggest that the model performs well in explaining and predicting the relationships between the studied constructs, enhancing its credibility and utility for addressing the research objectives (Lim et al., 2022).

Table 5: Model fitness

Q^2 predict	RMSE	MAE
0.760	0.070	0.081

RMSE: Root mean square error; MAE: Mean absolute error

Table 6 presents R-squared (R^2) values for various variables in the research model, providing insights into the extent to which these variables explain the variance in their respective dependent constructs. Notably, "Actions" exhibit a substantial R^2 of 0.851, indicating that approximately 85.1% of the variance in organizational actions within the context of the study can be attributed to the independent variables considered. In contrast, "Innovation Climate" shows an R^2 of 0.205, suggesting that around 20.5% of the variation in the innovation climate within organizations can be

accounted for by the independent variables in the model. For "Innovation Performance," the R^2 value stands at 0.556, indicating that approximately 55.6% of the variability in innovation performance outcomes can be explained by the independent variables under examination. Furthermore, "Process Innovation" and "Product Innovation" demonstrate substantial R^2 values of 0.790 and 0.747, respectively, signifying that a significant proportion of the variance in these innovation outcomes can be attributed to the variables included in the research model. Lastly, "Strategies" displays a high R^2 of 0.868, suggesting that approximately 86.8% of the variance in organizational strategies can be accounted for by the independent variables considered, emphasizing the strong explanatory power of the model for this construct. These R^2 values collectively highlight the model's ability to elucidate the relationships between the selected variables and their respective organizational outcomes (**Table 6**).

Table 6: R-square

Variable	R-square
Actions	0.851
Innovation climate	0.205
Innovation performance	0.556
Process innovation	0.790
Product innovation	0.747
Strategies	0.868

Table 7 presents F-statistics, offering insights into the significance of the relationships between independent and dependent variables within the research model. Notably, "Green Innovation" demonstrates notable impacts on "Actions" ($F = 5.692$) and "Strategies" ($F = 6.551$), underscoring its substantial role in explaining variance in these dependent constructs. Conversely, "Innovation Performance" reveals significant relationships with "Process Innovation" ($F = 3.754$) and "Product Innovation" ($F = 2.959$), emphasizing the importance of these independent variables in contributing to innovation performance outcomes. The specific F-statistics for "Environmental Leadership" and "Innovation Climate" concerning their influences on dependent constructs are not explicitly presented in **Table 7** but it would be important to infer their significance. These F-statistics collectively provide valuable insights into the pivotal drivers within the research model and their impacts on the studied organizational outcomes (**Table 7**).

Table 7: F-statistics

	Actions	Innovation climate	Innovation performance	Process innovation	Product innovation	Strategies
Environmental leadership			0.446			
Green innovation	5.692	0.257	0.201			6.551
Innovation climate			0.059			
Innovation performance				3.754	2.959	

Table 8 presents the results of the path analysis, offering insights into the relationships and effects of the key variables in the research model. These results are crucial for understanding how green innovation, innovation climate, environmental leadership, and innovation performance are

interconnected within organizations in the studied context.

The path analysis among green innovation and innovation performance reveals a significant positive relationship ($\beta = 0.358, p < 0.001$) between Green Innovation and Innovation Performance. This finding

highlights that organizations emphasizing green innovation tend to achieve better innovation performance outcomes. This positive association stresses the strategic importance of sustainability-driven innovation practices in enhancing overall organizational innovation performance. Moreover, the analysis of green innovation and innovation climate also demonstrates a strong positive relationship ($\beta = 0.452, p < 0.001$) between Green Innovation and Innovation Climate. This suggests that as organizations prioritize and invest in green innovation initiatives, they foster a more supportive and innovative work environment. The result indicates that green innovation practices positively contribute to shaping the overall innovation climate within organizations.

The third hypothesis path analysis reveals a significant negative relationship ($\beta = -0.214, p =$

0.007) between Innovation Climate and Innovation Performance (Fig. 3). This surprising finding suggests that a more favorable innovation climate is associated with lower innovation performance. This might prompt further investigation to explore the underlying factors influencing this counterintuitive relationship. Moreover, the mediating analysis also explores the mediating role of Innovation Climate in the relationship between Green Innovation and Innovation Performance. It indicates a significant indirect effect ($\beta = -0.097, p = 0.015$), suggesting that Innovation Climate partially mediates the relationship between Green Innovation and Innovation Performance. This implies that while Green Innovation has a direct positive impact on Innovation Performance, part of this influence is channeled through its effects on the organizational innovation climate (Fig. 3).

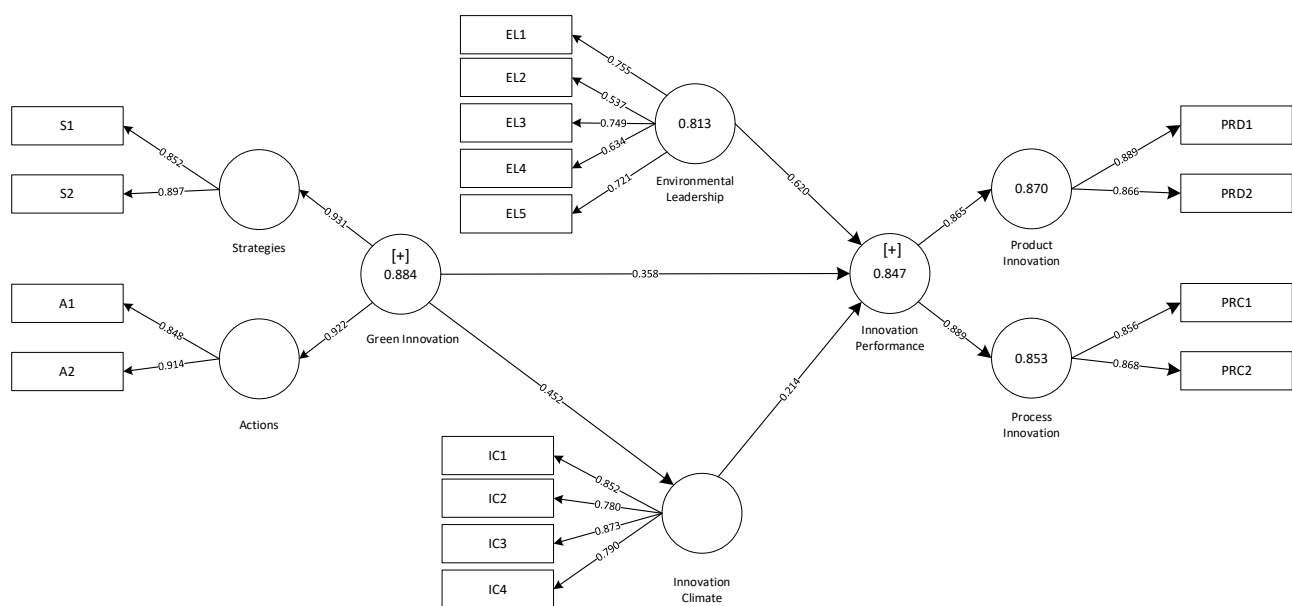


Fig. 3: Structural model

The moderating path analysis reveals that Environmental Leadership plays a significant moderating role ($\beta = -0.133, p < 0.001$) in the relationship between Green Innovation and Innovation Performance. This indicates that the impact of Green Innovation on Innovation Performance varies depending on the level of Environmental Leadership. Strong environmental leadership amplifies the positive relationship between Green Innovation and Innovation Performance, emphasizing the importance of leadership commitment to sustainability initiatives. In summary, the path analysis results provide

valuable insights into the dynamics of green innovation, innovation climate, environmental leadership, and innovation performance within organizations (Table 8). They emphasize the critical role of green innovation in enhancing innovation performance and innovation climate while also highlighting the complex effects of environmental leadership and innovation climate on innovation outcomes. These findings contribute to a deeper understanding of how organizations can strategically leverage sustainability initiatives to drive innovation and ultimately improve their performance (Table 8).

Table 8: Path analysis

	Original sample	Standard deviation	T statistics	P values
Green innovation significantly influences innovation performance of organizations	0.358	0.100	3.578	0.000
Green innovation significantly influences innovation climate of organizations	0.452	0.085	5.313	0.000
Innovation climate significantly influences innovation performance of organizations	-0.214	0.078	2.726	0.007
Innovation climate significantly mediates the relationship between green innovation and innovation performance of organizations	-0.097	0.040	2.437	0.015
Environmental leadership significantly moderates the relationship between green innovation and innovation performance of organizations	-0.133	0.034	3.946	0.000

5. Discussion

This research's discussion chapter explores the research findings in depth, making connections to the body of literature and highlighting the importance of the findings in relation to organizations operating industrial sectors in Saudi Arabia, Minerals, and Water Desalination sectors in the Kingdom of Saudi Arabia. It focuses on the ramifications of the findings and how, in this particular context, they add to a wider understanding of environmental leadership, innovation climate, green innovation, and innovation performance.

The findings of this study confirm the positive relationship between green innovation and Innovation Performance, aligning with previous research (Abbas and Sağsan, 2019). Organizations actively engaged in environmentally sustainable practices and green innovation tend to exhibit higher levels of innovation performance. This result emphasizes the strategic significance of sustainability-driven innovation for companies operating in environmentally sensitive industries in the Kingdom of Saudi Arabia. It reinforces the notion that aligning innovation efforts with ecological sustainability goals can yield substantial competitive advantages. The study also reveals a strong positive relationship between green innovation and innovation climate. This finding echoes previous research highlighting that organizations investing in green innovation initiatives foster a more supportive innovation climate (Le, 2022). The significance of this result lies in recognizing that a culture of sustainability and environmentally responsible practices can enhance the overall work environment and encourage employees to engage in innovative activities. This alignment between green innovation and innovation climate is vital for nurturing innovation ecosystems within organizations.

Moreover, somewhat unexpected results emerge from the relationship between innovation climate and innovation performance, which shows a negative association. This contrasts with the prevailing view that a positive innovation climate leads to better innovation performance (Khan et al., 2023). This finding warrants careful consideration and suggests that the innovation climate within organizations in the Kingdom of Saudi Arabia may have unique characteristics. Further investigation is necessary to understand the underlying factors driving this relationship and to explore potential strategies for enhancing innovation performance within the context of a favorable innovation climate. The study introduces the mediating role of innovation climate in the relationship between green innovation and innovation performance. This is consistent with the literature emphasizing that an innovative work environment mediates the impact of green innovation on innovation outcomes (Qu et al., 2022). Recognizing this mediation stresses the importance of cultivating a supportive innovation climate as an intermediary step in translating green

innovation efforts into enhanced innovation performance. Environmental leadership emerges as a significant moderator in the relationship between green innovation and innovation performance. This finding aligns with previous research highlighting the importance of leadership commitment to sustainability initiatives (Zhang and Ma, 2021). In the context of the Kingdom of Saudi Arabia, where the oil and energy sectors have a substantial environmental footprint, the role of leadership in championing sustainability and green innovation initiatives becomes pivotal. Strong environmental leadership amplifies the positive impact of green innovation on innovation performance, emphasizing the need for visionary leaders to drive sustainability-driven innovation.

In conclusion, this research sheds light on the complex associations of green innovation, environmental leadership, innovation climate, and innovation performance in organizations within the Kingdom of Saudi Arabia. It reaffirms the strategic importance of sustainability-driven innovation practices, emphasizes the role of leadership, and provides insights into the unique contextual factors influencing innovation outcomes. By bridging empirical findings with existing literature, this study contributes to the understanding of how organizations in environmentally sensitive sectors can thrive through green innovation and embrace sustainability as a catalyst for innovation and performance excellence.

6. Conclusion

In conclusion, this research has provided valuable insights into the relationships of green innovation, environmental leadership, innovation climate, and innovation performance within organizations operating in industrial sectors in Saudi Arabia. The findings have confirmed the positive relationship between green innovation and innovation performance, emphasizing the strategic significance of sustainability-driven innovation initiatives. Furthermore, the mediating role of innovation climate and the moderating role of environmental leadership shows a significant impact of their existence, highlighting the importance of leadership commitment and fostering a conducive work environment for innovation. While the negative association between innovation climate and innovation performance warrants further exploration, these results collectively contribute to a deeper understanding of how organizations in this specific context can leverage green innovation to enhance their innovative capabilities and overall performance.

This research serves as a foundation for future investigations into sustainability-driven innovation within environmentally sensitive industries, offering actionable insights for organizational leaders and policymakers seeking to navigate the evolving landscape of sustainable business practices.

6.1. Implications of the study

This research offers several significant managerial implications for organizations in the Oil, Gas, Electricity, Minerals, and Water Desalination sectors in the Kingdom of Saudi Arabia. Firstly, it emphasizes the critical importance of embracing green innovation as a strategic initiative. Managers and leaders should recognize that investing in environmentally sustainable practices and innovative solutions can substantially enhance innovation performance and competitive advantage. This implies the need to align innovation strategies with ecological sustainability goals to thrive in an ever-evolving business landscape. Moreover, the study emphasizes the indispensable role of environmental leadership. Managers and organizational leaders should take the initiative to champion sustainability-driven innovation. Their unwavering commitment and vision set the tone for the entire organization, fostering a culture where green innovation is not just encouraged but integral to the organizational ethos. Additionally, the research points out the importance of cultivating a supportive innovation climate. While the relationship between innovation climate and innovation performance appears significantly important, creating a work environment that promotes open communication, idea-sharing, and experimentation remains crucial. Organizations should prioritize efforts to nurture such an environment, as it can contribute to more successful innovation outcomes. Furthermore, it's vital to recognize the mediating role of the innovation climate. Managers should understand that it acts as a crucial intermediary step between green innovation initiatives and innovation performance. Fostering a conducive work environment that encourages creativity and collaboration is, therefore, key to translating green innovation efforts into tangible improvements in innovation performance.

The theoretical implications of this research extend beyond the managerial domain. It contributes to the broader theoretical understanding of green innovation, environmental leadership, innovation climate, and innovation performance. The study's findings challenge some conventional assumptions while reinforcing others: The research reveals a somewhat unexpected negative relationship between innovation climate and innovation performance. This calls for a more complex examination of the factors influencing this dynamic within the specific context of the Kingdom of Saudi Arabia. Theoretical frameworks should be refined to incorporate contextual factors that might explain this counterintuitive relationship. The introduction of the mediating role of innovation climate enriches theoretical perspectives on how green innovation impacts innovation performance. It highlights the significance of organizational climate as an intermediary process, necessitating further exploration in the realm of innovation theory. The study highlights the importance of environmental

leadership in amplifying the effects of green innovation. Theoretical models should incorporate leadership as a critical moderator in the relationship between sustainability-driven innovation and organizational outcomes, providing a more comprehensive understanding of the mechanisms at play.

In sum, the research contributes theoretical insights by shedding light on the complex relationships of green innovation and its impacts on innovation climate and performance within a specific context. These findings open avenues for further theoretical exploration, enriching our understanding of how sustainability-driven innovation operates in practice.

6.2. Limitations and future research directions

While this research contributes valuable insights into the relationships of green innovation, environmental leadership, innovation climate, and innovation performance in the context of organizations in the Kingdom of Saudi Arabia, it is essential to acknowledge certain limitations that should be considered when interpreting the findings. Firstly, the study focused on a specific geographical context and industry sectors in Saudi Arabia. Therefore, the generalizability of the results to other industries or regions may be limited. Future research should encompass a more diverse range of industries and geographical contexts to ascertain the broader applicability of the findings. Secondly, the research employed cross-sectional data, which provides a snapshot of relationships at a single point in time. This design restricts the ability to establish causality definitively. Longitudinal or experimental designs could provide more robust insights into the dynamics among the variables over time. Thirdly, the measurement scales used in the study, while validated, are based on self-reported data, which may introduce common method bias. Future research could employ multiple data collection methods or incorporate objective measures to mitigate this limitation.

In the realm of future research directions, one promising avenue is to investigate the role of external stakeholders, such as government policies and regulations, industry standards, and consumer preferences, in shaping the green innovation landscape within organizations. Understanding how external factors influence the adoption and success of green innovation initiatives can provide valuable insights for both scholars and practitioners. Additionally, exploring the impact of global trends, such as climate change mitigation and sustainable development goals, on organizations' green innovation strategies can shed light on the broader societal and environmental context in which these initiatives operate. Furthermore, future research can delve deeper into the relationship between green innovation and corporate financial performance. Analyzing whether sustainability-driven innovation translates into tangible financial benefits for

organizations can provide a more comprehensive perspective on the business case for green innovation. Additionally, examining the potential trade-offs between short-term financial gains and long-term sustainability goals can help organizations make informed decisions about their innovation strategies. This research direction aligns with the growing interest in sustainable finance and responsible investment practices, where the integration of environmental, social, and governance (ESG) factors into investment decisions is gaining momentum.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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