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Green Innovation and Its Effects on Innovation Climate and Environmental Sustainability: The Moderating Influence of Green Abilities and Strategies

Khalid H. Alshammari * and Abdulhamid F. Alshammari

Department of Management and Information Systems, College of Business Administration, University of Ha'il, P.O. Box 2440, Ha'il 81451, Saudi Arabia; hamid.alshammari@uoh.edu.sa
* Correspondence: khha.alshammari@uoh.edu.sa

Abstract: This research aims to explore the relationship among environmental sustainability, work environment, green innovation, and industrial companies' innovation climate. The purpose of this exploration was to find out the explanation of how these variables influence each other and how they play a role in organizations sustainability. The study collected data from 253 employees in the Kingdom of Saudi Arabia's oil and gas, minerals, and mining sectors. It employed the Warps analysis method to assess the relationships between green innovation, innovation climate, and environmental sustainability. By applying well-established theoretical frameworks, including the Innovation Diffusion Theory and Environmental Sustainability Theory, the research aims to provide a comprehensive understanding of the dynamics at play. The findings affirm the significant and positive relationships between green innovation and both environmental sustainability and the innovation climate within industrial firms. Moreover, the study highlights the mediating role of the innovation climate, which serves as a bridge connecting green innovation with environmental sustainability outcomes. Additionally, green motivational strategies and green abilities were identified as moderators that enhance the effectiveness of green innovation practices. This research carries practical and theoretical implications. It provides valuable insights for industrial firms seeking to integrate sustainability practices into their operations, enhance their innovation climate, and optimize their green innovation initiatives. The findings bridge the gap between theory and practice, guiding managerial decision-making and facilitating the implementation of sustainable practices. Moreover, the study enriches the theoretical foundations of sustainability and innovation by applying established theories to the industrial context, contributing to a more holistic understanding of these critical concepts in the modern business landscape.

Keywords: green innovation; innovation climate; environmental sustainability; green motivational strategies; green abilities

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1. Introduction

Climate change and environmental degradation are two major issues that nations throughout the world are currently facing. Green innovation and environmental sustainability are two critical aspects in today's rapidly changing world in this regard [1]. As the globe faces environmental and technological problems, the need to achieve a balance between innovation and sustainability has never been clearer [2]. Green innovation represents a deliberate shift towards eco-friendly technologies, practices, and processes within organizations [3]. It is the driving force behind sustainable solutions and responsible business practices [4]. On the other hand, environmental sustainability is the overarching goal of minimizing harm to the environment while ensuring the long-term viability of our planet [5]. It encompasses everything from reducing carbon footprints to conserving natural resources [3].

Prior research has extensively examined the individual dimensions of green innovation and environmental sustainability [5,6]. Scholars have probed deeply into the significance of green innovation, explicating its capacity to reduce resource consumption, mitigate waste generation, and curb harmful emissions [7]. These investigations have also illuminated how green innovation can enhance operational efficiency and bolster market competitiveness [8].

In tandem, the impact of environmental sustainability on corporate responsibility, brand reputation, and overall competitiveness has been well-documented. These past studies underscore the immense importance of both green innovation and environmental sustainability within a rapidly evolving global landscape [9–11]. However, they also point towards a critical gap in the literature [12], the need to comprehensively explore the intricate relationships between these two pivotal variables. While the individual roles of green innovation and environmental sustainability have been well-established [13], their mutual influence and interconnectedness remain relatively uncharted territory, paving the way for further inquiry.

Within the realm of sustainability and innovation, the relationship between green innovation and environmental sustainability has garnered substantial attention [14]. Several studies have offered valuable insights into the potential connections between these two variables [5,6,15]. For instance, research has suggested that organizations actively engaged in green innovation tend to exhibit a heightened commitment to environmental sustainability objectives [15]. By adopting eco-friendly technologies and practices, these organizations contribute to the reduction of resource consumption and environmental harm [16]. Additionally, there is evidence to suggest that the pursuit of environmental sustainability can stimulate innovation, driving organizations to explore and implement sustainable solutions in their operations [17]. These findings underscore the interplay between green innovation and environmental sustainability, pointing towards complex relationships that warrant further empirical investigation.

Past research has consistently recommended a more comprehensive examination of the relationships between green innovation and environmental sustainability [18]. Scholars have emphasized the importance of understanding how innovative practices contribute to sustainable outcomes and how a dedicated commitment to environmental sustainability can stimulate innovative solutions [19,20]. These recommendations have called for empirical studies that bridge the gap between the two variables [21], shedding light on the mechanisms through which they interact and influence each other. As organizations increasingly recognize the significance of both green innovation and environmental sustainability [22–24], there is a growing need for evidence-based insights into the dynamics of these relationships. By investigating these interconnections, research can offer valuable guidance to organizations seeking to navigate the intersection of innovation and sustainability in a rapidly evolving world.

To underpin this research's exploration of the relationships between green innovation and environmental sustainability, we draw on established theoretical frameworks. The Innovation Diffusion Theory provides a structured perspective on how innovation spreads within organizations, offering valuable insights into the pathways through which green innovation can impact environmental sustainability outcomes [25]. Additionally, the Environmental Sustainability Theory guides our understanding of how sustainability practices become integrated into organizational processes [26]. By incorporating these theoretical foundations, this study seeks to empirically investigate and contribute to the growing body of knowledge on the interconnectedness of green innovation and environmental sustainability. These theories offer a robust framework through which we can delve deeper into the intricate dynamics of these variables [27,28], providing a foundation for our research methodology and analysis. With these theories as a foundation, this research sets out to achieve several primary objectives: (1) assess the tangible impact of green innovation on environmental sustainability and the innovation climate within industrial firms, (2) explore the mediating role of the innovation climate in connecting green innovation practices with environmental sustainability outcomes, and (3) investigate the moderating effects of vari-

ables such as green motivational strategies and green abilities on the intricate relationships between green innovation, innovation climate, and environmental sustainability.

2. Literature Review

There is a significant body of literature that has been published on the topic of green innovation and environmental sustainability. Against the backdrop of pressing global environmental challenges, the significance of green innovation and environmental sustainability has surged in recent years [21]. Climate change, biodiversity loss, and resource depletion are increasingly linked to human activities [29]. The intersection of innovation and sustainability is currently the subject of much research. This research seeks to understand how innovative ideas and tools can mitigate environmental degradation and pave the way for a more sustainable future [18]. Central to discussions on green innovation is the concept of transformative advancements in technology, processes, and products that aim to minimize or eliminate adverse environmental impacts [17]. These innovations span a wide spectrum, encompassing areas such as renewable energy technologies, environmentally friendly materials, sustainable agricultural practices, and circular economy models [26]. In parallel, environmental sustainability emphasizes the imperative of preserving the planet's ecosystems over the long term. It advocates for responsible resource management, the conservation of the environment, and meeting current needs without compromising the needs of future generations [3]. This perspective underscores the idea of the "triple bottom line", which calls for organizations and institutions to balance economic prosperity with social well-being and ecological stewardship [21].

Within the academic realm, these concepts find theoretical grounding in various frameworks. The diffusion of innovations theory, for instance, plays a crucial role in examining how new green technologies and practices spread through markets and society [5]. The concept of disruptive innovation is commonly employed to assess the potential of disruptive green technologies to reshape industries and markets [19]. Concurrently, sustainability frameworks, such as the United Nations Sustainable Development Goals (SDGs) and the Natural Step Framework, provide systematic approaches for corporations and policymakers to integrate environmental sustainability into their strategies and decision-making processes [30].

Nevertheless, when scholars dig into the domains of green innovation and environmental sustainability, they encounter a range of obstacles [27]. Developing green technologies often necessitates substantial investments in research and development, and the path to overcoming technological barriers can be arduous [10]. Additionally, regulatory and policy landscapes wield significant influence over the trajectory of green innovation, requiring researchers to assess the impact of various policy frameworks on environmental sustainability initiatives [21]. Furthermore, understanding consumer behaviors and attitudes toward green products and services is essential, as consumer choices play a pivotal role in shaping market demand for sustainable alternatives [14]. In this complex landscape, academic research strives to illuminate the path forward, offering insights and solutions to propel the green innovation agenda towards a more sustainable future [1].

Innovation climate and work environment are two pivotal dimensions within the organizational landscape that have garnered substantial attention in the context of green innovation [7]. Innovation climate refers to the prevailing conditions, norms, and attitudes within an organization that either foster or hinder innovative behaviors and practices [15]. It encompasses aspects such as leadership support, open communication channels, encouragement of risk-taking, and a culture of continuous improvement. In the realm of green innovation, a positive innovation climate is critical [22]. It stimulates employees to proactively engage in environmentally sustainable practices, develop green ideas, and contribute to the organization's broader sustainability goals [30]. Organizations with a conducive innovation climate are better positioned to implement eco-friendly innovations, reduce resource consumption, and minimize environmental impact [11].

The work environment, often encompassing aspects such as green motivational strategies and green abilities, is another significant factor in the context of green innovation. A work environment that promotes green thinking and practices can be a catalyst for sustainable innovation [14]. Green motivational strategies, such as offering incentives for eco-friendly behaviors or providing training and resources for employees to adopt green practices, can substantially shape employees' attitudes and behaviors towards environmental sustainability [17]. Likewise, the development of green abilities, including skills, knowledge, and competencies related to green technologies and practices, is integral. These abilities empower employees to engage in the ideation and implementation of green innovations [1]. In the dynamic interplay between innovation climate, work environment, and green innovation, organizations have the opportunity to not only reduce their environmental footprint but also stay competitive in a world increasingly focused on sustainable solutions [19]. The relationship between innovation climate, work environment, and green innovation is a complex yet promising avenue for further exploration, with the potential to yield valuable insights into fostering a more sustainable future [23].

3. Hypotheses Development

3.1. Green Innovation and Environmental Sustainability

Green innovation, defined as the deliberate creation and deployment of new technologies, processes, products, and behaviors with the goal of reducing or eliminating negative environmental impacts, has received a lot of attention in the context of environmental sustainability [11]. The scholarly literature on this topic is filled with evidence supporting green innovation's essential role in achieving environmental sustainability [3]. Notably, eco-friendly innovations encompass a wide spectrum, ranging from renewable energy technologies and sustainable agriculture practices to waste reduction strategies and circular economy models [31]. These innovations have consistently demonstrated their capacity to curtail resource depletion, reduce emissions, and ameliorate environmental degradation [32]. A multitude of research has established the fundamental role of green innovation in enhancing environmental sustainability [5]. The findings of Baah, Opoku-Agyeman [24] and Huang and Chen [19] indicate that the allocation of resources towards green innovation, including various forms of renewable energy technology and environmentally conscious production methods, results in significant decreases in resource consumption, greenhouse gas emissions, and overall environmental degradation. These technological advancements play a significant role in the attainment of sustainability objectives and are in accordance with the concepts of the triple bottom line [11]. Such findings underscore the pivotal role of green innovation in fostering environmentally responsible practices and ensuring a more sustainable future [7].

Empirical studies reinforce this hypothesis by revealing tangible linkages between green innovation and improved environmental sustainability outcomes. Numerous corporate examples showcase how investments in green research and development (R&D) and the adoption of environmentally friendly practices lead to substantial reductions in ecological footprints [5,33]. Moreover, case studies across diverse industries consistently portray green innovation as a catalyst for elevated environmental performance [12]. Theoretical support for this hypothesis derives from the Innovation Diffusion Theory, which posits that the widespread adoption of green innovations, as a subset of innovations, can engender profound shifts in organizational and societal norms [34].

In essence, as green innovations diffuse across sectors, they contribute cumulatively to enhanced environmental sustainability [11]. This theoretical framework underscores the significance of green innovation in influencing behavior, processes, and practices toward more sustainable ends [27].

Hypothesis 1 (H1). *Green innovation significantly affects environmental sustainability.*

3.2. Green Innovation and Innovation Climate

The concept of the innovation climate, encapsulating the organizational and cultural conditions conducive to innovation, has emerged as a key factor in organizational studies [7]. In the context of green innovation, a burgeoning body of research posits that prioritizing eco-friendly innovation initiatives significantly influences the overall innovation climate within organizations [31]. The literature recognizes the profound impact of green innovation on the innovation climate within organizations [10]. Notably, studies by Lin and Ma [17] and Marco-Lajara, Zaragoza-Sáez [22] emphasize how green innovation initiatives can create a culture of sustainability-oriented creativity and experimentation. Green innovation, by its nature, demands cross-functional collaboration and resource allocation for sustainability, fostering a culture that encourages openness to change and continuous improvement [8]. These findings underscore how green innovation can be a catalyst for shaping an innovation-friendly climate, ultimately enhancing an organization's ability to adapt and thrive in a rapidly changing environmental landscape [10]. The scholarly discourse highlights how green innovation fosters an innovation-friendly environment [31]. This is attributed to several inherent characteristics of green innovation, including its tendency to necessitate cross-functional collaboration, allocation of resources towards sustainability-oriented projects, and a commitment to developing environmentally responsible products and processes [7]. These attributes, in turn, contribute to the creation of a positive innovation climate [20].

Empirical investigations support this hypothesis by demonstrating that organizations actively promoting green innovation tend to exhibit features indicative of an innovation-friendly culture. Such organizations are characterized by their receptivity to change, a dedication to continuous improvement, and a culture that places a premium on creativity, particularly when it aligns with sustainability goals [30]. Theoretical grounding for this hypothesis is found in both the Innovation Diffusion Theory and the Environmental Sustainability Theory [14]. The former asserts that green innovation, as a form of innovation, plays a role in reshaping the organizational culture and climate by encouraging the acceptance of novel ideas and technologies [28]. The latter theory reinforces this perspective, contending that green innovation nurtures a culture of sustainability-oriented innovation, aligning closely with the organization's overarching commitment to environmental sustainability [3]. Together, these theories substantiate the hypothesis that green innovation significantly influences the innovation climate within organizations [10].

Hypothesis 2 (H2). *Green innovation significantly affects the innovation climate.*

3.3. Innovation Climate and Environmental Sustainability

The innovation climate, representing the broader organizational and cultural context that either fosters or inhibits innovation, holds a pivotal role in the pursuit of environmental sustainability goals [20]. Scholarly exploration underscores the pivotal role of the innovation climate in shaping environmental sustainability outcomes [8]. Research by Ogbeibu, Pereira [7,18] elucidates how an organizational climate that supports innovation, characterized by leadership commitment, open communication, and a culture valuing creativity, contributes positively to environmental sustainability efforts. Such environments enable the integration of sustainable practices and technologies, resulting in improved environmental performance [28]. These findings accentuate the interconnectedness of organizational culture and environmental sustainability, emphasizing the significance of fostering an innovation climate to achieve sustainability goals [30].

Extensive scholarly exploration reveals that the characteristics of an organization's innovation climate have a substantial impact on its environmental sustainability outcomes [27]. An innovation climate characterized by leadership support for innovation, transparent and open communication channels, and an ethos that encourages creativity, experimentation, and risk-taking, plays a critical role in shaping the environmental practices of an organization [24]. Organizations with a favorable innovation climate are more likely

to embrace and champion green initiatives, including the adoption of eco-friendly technologies, sustainable processes, and responsible sourcing [33]. Such practices inherently contribute positively to environmental sustainability by reducing resource consumption, waste generation, and environmental harm [14]. Empirical studies further underscore this hypothesis by providing empirical evidence that organizations with supportive innovation climates tend to exhibit superior environmental performance, meeting, or surpassing sustainability goals [10,22]. The literature thus highlights that a conducive innovation climate can serve as a catalyst for the integration of sustainability principles into an organization's operations, thereby enhancing environmental sustainability outcomes [4,21].

Hypothesis 3 (H3). *Innovation climate significantly affects environmental sustainability.*

3.4. Innovation Climate Mediates the Relationship of Green Innovation and Environmental Sustainability

The mediation role of the innovation climate in the relationship between green innovation and environmental sustainability emerges as a crucial consideration [17]. Building upon prior hypotheses, the scholarly discourse underscores the innovation climate as a central mediator that shapes the nature and strength of the connection between green innovation and environmental sustainability [26]. Green innovation, with its inherent focus on sustainable technologies, practices, and processes, can set in motion a positive feedback loop within organizations characterized by an innovation-friendly climate [9]. Such a climate encourages the acceptance and diffusion of green innovations across the organization [6]. This, in turn, amplifies the impact of green innovations on environmental sustainability outcomes [10]. Studies by Fan, Abbas [27] and Lin and Ma [17] shed light on the mediating role of the innovation climate in the relationship between green innovation and environmental sustainability. The innovation climate acts as an intermediary, amplifying the positive effects of green innovation on sustainability outcomes [19]. It creates an environment where green innovations are embraced, diffused, and effectively integrated into organizational practices, resulting in enhanced sustainability performance [15]. These findings reinforce the idea that the innovation climate plays a critical role in driving the success of green innovation initiatives and their ultimate impact on environmental sustainability [12].

Empirical studies provide empirical support for this mediation hypothesis, illustrating that the innovation climate acts as an intermediary that magnifies the effects of green innovation on environmental sustainability outcomes [4]. In organizations with a supportive innovation climate, green innovation initiatives tend to be more successful and influential in driving sustainability objectives [6]. The theoretical underpinning of this hypothesis aligns with the Innovation Diffusion Theory, which posits that the innovation climate can enhance the influence of green innovations by facilitating their diffusion and adoption [34]. In summary, this hypothesis posits that the innovation climate plays a significant mediating role in the relationship between green innovation and environmental sustainability, intensifying the positive impact of green innovation initiatives on sustainability outcomes within organizations [27]. The innovation climate acts as a bridge that amplifies and channels the effects of green innovation towards achieving enhanced environmental sustainability goals [8].

Hypothesis 4 (H4). *Innovation climate significantly mediates the relationship of green innovation and environmental sustainability.*

3.5. Green Abilities Moderates the Relationship of Green Innovation and Environmental Sustainability

In hypothesis five, we explore the role of individuals' attitudes toward environmental sustainability, referred to as "developing green abilities," as a potential moderator in the relationship between green innovation and environmental sustainability outcomes [10]. Developing green ability denotes an individual's inclination and commitment to embracing

environmentally responsible behaviors and practices [14]. Academic literature emphasizes the significance of individual and organizational attitudes in shaping the impact of green innovation on environmental sustainability [7]. Scholars argue that individuals with a strong commitment to environmental sustainability are more likely to actively engage with and support green innovation initiatives [27]. These individuals are inclined to champion and embrace environmentally friendly technologies, processes, and products [31]. Their enthusiasm can drive the successful implementation of green innovations, leading to improved environmental sustainability outcomes [17]. Research by Luo and Mabrouk [5] and Sandra Marcelline, Chengang [13] highlights the moderating role of developing green abilities in the relationship between green innovation and environmental sustainability. Individuals with strong commitments to sustainability are more likely to actively engage in green innovation initiatives, driving the successful implementation of eco-friendly technologies and practices [21]. These individuals, as active change agents, enhance the link between green innovation and sustainability outcomes [9]. Such studies emphasize the importance of considering individual attitudes as influential factors that can amplify the positive effects of green innovation on environmental sustainability [27].

Empirical research has offered proof in favor of this theory. Studies have indicated that companies with a workforce that demonstrates a strong dedication to sustainability typically outperform others when it comes to environmental sustainability [3]. Workers who are adopting greener attitudes are more likely to support sustainable practices, take an active role in green innovation projects, and make sure that green innovations are successfully incorporated into daily operations within the company [33]. The theoretical basis for this hypothesis lies in the concept of moderation in social science research. Developing green abilities is posited as a moderating variable that influences the strength and direction of the relationship between green innovation and environmental sustainability [18]. The idea is that the impact of green innovation on environmental sustainability is contingent on the level of developing green abilities within an organization [4]. When developing green abilities are high, it enhances the positive relationship between green innovation and environmental sustainability, leading to more significant and lasting improvements in sustainability outcomes [8].

Hypothesis 5 (H5). *Developing green abilities significantly moderates the relationship of green innovation and environmental sustainability.*

3.6. Green Motivational Strategies Moderate the Relationship of Green Innovation and Environmental Sustainability

Sixth hypothesis explores the role of organizational strategies aimed at motivating individuals to engage in environmentally sustainable behaviors, referred to as "green motivational strategies," as moderators in the relationship between green innovation and environmental sustainability [10]. The academic literature emphasizes the importance of motivating strategies in influencing individuals' engagement with green innovation and their subsequent impact on environmental sustainability [5]. Green motivational strategies encompass a range of approaches, such as incentive programs, recognition systems, and training initiatives, designed to inspire and incentivize individuals to actively participate in green innovation initiatives [12]. The literature, as seen in studies by Lin and Ma [17] and Sandra Marcelline, Chengang [13], elucidates the moderating role of green motivational strategies in shaping the relationship between green innovation and environmental sustainability. Organizational strategies that motivate individuals to embrace eco-friendly practices can intensify the impact of green innovation on sustainability outcomes [15]. Effective strategies, such as incentive programs, recognition systems, and training initiatives, inspire employees to actively participate in green innovation initiatives and champion sustainability goals [35]. These studies highlight the importance of organizational strategies in enhancing the link between green innovation and environmental sustainability, emphasizing the role of motivation in driving sustainable practices and outcomes [36].

Empirical studies have demonstrated that organizations employing effective green motivational strategies tend to experience more substantial positive effects from their green innovation efforts on environmental sustainability [37]. Such strategies encourage employees to embrace green technologies, practices, and products, leading to greater success in reducing environmental impacts [17]. The theoretical support for this hypothesis is grounded in the concept of moderation, wherein green motivational strategies are considered as moderators that influence the relationship between green innovation and environmental sustainability [18]. The hypothesis posits that the impact of green innovation on environmental sustainability outcomes is contingent on the presence and effectiveness of green motivational strategies [35]. When these strategies are well-implemented and motivate individuals effectively, they enhance the positive relationship between green innovation and environmental sustainability, resulting in more significant and sustained improvements in sustainability outcomes within the organization [10].

Hypothesis 6 (H6). *Green motivational strategies significantly moderate the relationship of green innovation and environmental sustainability.*

In the realm of academic research, a comprehensive framework emerges from these hypotheses that elucidate the intricate relationships governing green innovation and its impact on environmental sustainability (see Figure 1). It begins with the direct influence of green innovation on environmental sustainability, acknowledging the transformative power of eco-friendly practices and technologies [38]. This influence is further contextualized within the organizational landscape through the innovation climate, which can both shape and be shaped by green innovation initiatives [39]. The innovation climate's mediating role underscores its significance as an amplifier of green innovation's effects on environmental sustainability [40]. Expanding beyond organizational dynamics, individual factors are introduced: developing green abilities and green motivational strategies [41]. These variables collectively illustrate how individual inclinations and organizational strategies can moderate the relationship between green innovation and environmental sustainability, offering a holistic perspective on the intricate web of factors that contribute to sustainable practices and outcomes [33].

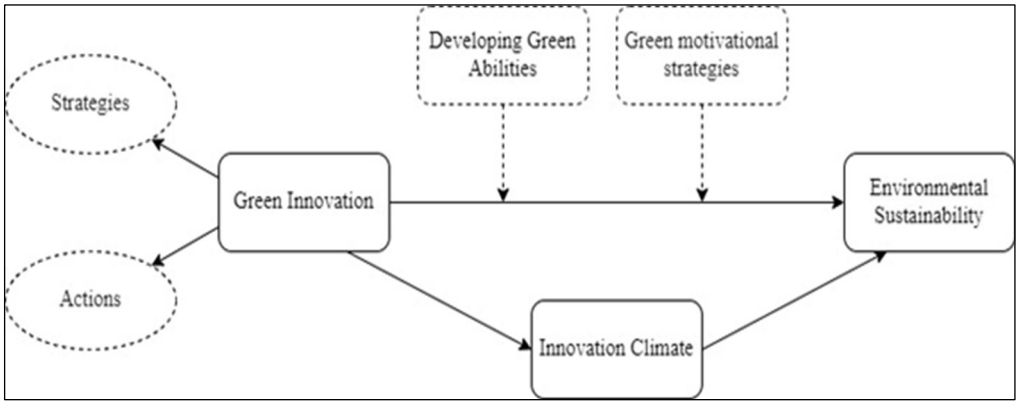

Figure 1. Conceptual and Theoretical Model.

4. Methodology

In this study, data was collected from 253 employees representing companies in the oil and gas, minerals, and mining sectors located in the Kingdom of Saudi Arabia. The choice of this specific industry and region is particularly significant, given the substantial role of these sectors in the Saudi Arabian economy and their impact on global energy and resource markets. Data collection employed a structured survey questionnaire administered to the employees. The questionnaire was designed to capture relevant information on variables related to green innovation, innovation climate, environmental sustainability, developing

green abilities, and green motivational strategies. Out of 450 distributed questionnaires, this study has received 253 acceptable responses for analysis (Table 1). It included established scales and items adapted from prior research to ensure content validity (Appendix A). To assess the green innovation the five questions from scale of Bahmani et al. (2023) [42] are used. For measuring the innovation climate, the four items from the scale of Tan and Lee (2019) [43] are used. To assess the environmental sustainability (five questions), developing green abilities (five questions) and green motivational strategies (four questions) the scale of Langat (2017) [44] is used. The data were collected through online surveys, and it took two months to collect the data.

Table 1. Demographics of respondents.

Gender	Distribution	Experience Range	Distribution
Male	201	1–3	29
Female	52	4–6	76
Age Group	Distribution	7–10	72
18–25	33	11–20	46
26–35	121	21–30	15
36–45	52	>30	15
46–55	22	Job Level	Distribution
56–65	15	CEO/VP/GM	2
>65	10	Manager/Head of Dept.	29
Education	Distribution	Supervisor/Team Leader	58
High School	13	Specialist/Technician	73
Diploma	88	Administrator/Clerical	91
Bachelor	107	Industry	Distribution
Master	42	Oil	49
PhD	3	Gas	51
Nationality	Distribution	Electricity	60
Saudi	157	Water Desalination	54
Non-Saudi	96	Mining	7
Sector	Distribution	Industrial Company	32
Government	28		
Private	178		
Semi-Government	47	Total	253

Data analysis was conducted using WarPLS (War-PLS), a robust statistical technique suitable for assessing relationships and conducting structural equation modeling, especially in cases where data may not conform to normal distribution assumptions. WarPLS is particularly valuable when dealing with non-linear relationships or smaller sample sizes, which makes it a fitting choice for this study. Equations for the hypotheses can be expressed as follows:

- H1: Environmental Sustainability = $\alpha + \beta 1 * \text{Green Innovation} + \varepsilon 1$
- H2: Innovation Climate = $\alpha + \beta 2 * \text{Green Innovation} + \varepsilon 2$
- H3: Environmental Sustainability = $\alpha + \beta 3 * \text{Innovation Climate} + \varepsilon 3$
- H4: Environmental Sustainability = $\alpha + \beta 4 * \text{Green Innovation} + \beta 5 * \text{Innovation Climate} + \varepsilon 4$
- H5: Environmental Sustainability = $\alpha + \beta 6 * \text{Green Innovation} + \beta 7 * \text{Developing Green Abilities} + \varepsilon 5$
- H6: Environmental Sustainability = $\alpha + \beta 8 * \text{Green Innovation} + \beta 9 * \text{Green Motivational Strategies} + \varepsilon 6$

In these equations, α represents the intercept, β represents the coefficients, and ε represents the error term. The hypotheses test the relationships between the variables as specified in your research. The survey data, once collected, underwent a step-by-step analysis through WarPLS 7.0.

The analysis process commenced with data screening and cleaning procedures to ensure data quality. Subsequently, the study explored the relationships between green

innovation, innovation climate, developing green abilities, green motivational strategies, and environmental sustainability using the WarPLS model. This comprehensive analysis included the examination of moderation and mediation effects, enabling a thorough exploration of how these variables interact within the context of the Saudi Arabian oil and gas, minerals, and mining sectors.

Furthermore, the study proactively addressed potential biases and sought to enhance the validity of the findings. Special efforts were made to ensure that the survey instrument was culturally and contextually appropriate for the Saudi Arabian setting. These measures were taken to strengthen the reliability and relevance of the research in the specified context. In addressing the potential for self-selection bias, this study meticulously employed several methodological cautious measures. This study implemented item rotation techniques, ensuring that respondents were presented with questions in a randomized order, thereby minimizing response bias. The survey was conducted in a blind manner, withholding specific study objectives from participants to further reduce the likelihood of self-selection based on perceptions of the research topic. These methodological choices reflect our commitment to rigorous research practices and the pursuit of unbiased, representative data. Ethical considerations were adhered to throughout the data collection process, including safeguarding their anonymity and confidentiality. Overall, this methodological approach allows for a rigorous examination of the relationships and dynamics under investigation, providing insights into the role of green innovation, innovation climate, and individual and organizational factors in influencing environmental sustainability within the specified industry and region.

5. Results

In Table 2, the study presents the reliability and validity assessments of the measurement model. Cronbach's alpha coefficients were calculated to evaluate the internal consistency of the constructs [45,46]. The results indicate that the constructs generally exhibit high levels of internal consistency, with Cronbach's alpha values ranging from 0.719 to 0.915. This suggests that the survey items measuring these constructs are reliable and consistent in capturing the intended aspects of the variables. Composite reliability coefficients were also calculated to assess the reliability of the constructs. The values for composite reliability range from 0.788 to 0.944, exceeding the recommended threshold of 0.7, indicating strong internal consistency and reliability of the measurement model. Additionally, Average Variance Extracted (AVE) values were computed to assess the convergent validity of the constructs. The AVE values range from 0.502 to 0.811, surpassing the threshold of 0.5, which suggests that each construct explains a substantial proportion of the variance in its respective items. This confirms that the constructs are adequately capturing the variance within the data. Overall, the results from Table 2 demonstrate the reliability and validity of the measurement model, providing confidence in the robustness of the data collected for further analysis in the study.

Table 2. Cronbach's alpha, Composite reliability, and AVE.

Cronbach's Alpha Coefficients						
GI	ES	IC	GMS	DGA	GMS×GI	DGA×GI
0.915	0.822	0.719	0.64	0.724	1	1
Composite reliability coefficients						
0.944	0.876	0.827	0.788	0.82	1	1
Average variances extracted						
0.811	0.59	0.546	0.502	0.581	1	1

GI = Green Innovation, ES = Environmental Sustainability, IC = Innovation Climate, GMS = Green Motivational Strategies, DGA = Developing Green Abilities.

Table 3 provides a comprehensive overview of the relationships between observed variables and their corresponding latent constructs. Notably, the Green Innovation con-

struct shows strong associations with its observed variables, underscoring their collective relevance in measuring the latent construct's essence. In a similar vein, the Environmental Sustainability indicators exhibit substantial loadings on their latent construct, indicating a robust link. Within the Innovation Climate construct, positive loadings for the observed variables (notably IC1 to IC4) signify their alignment with the latent construct. This emphasizes the importance of these variables in capturing the essence of the organization's innovation climate. Likewise, both green motivational strategies and developing green abilities constructs display significant loadings on their respective observed variables, corroborating their role in measuring these latent constructs effectively. The "Reflective" and "Formative" designations in the Type column signify the nature of the measurement model, distinguishing between reflective and formative constructs. Moreover, the statistical significance of all loadings ($p < 0.001$) reaffirms the robustness of the measurement model and the strength of associations between the observed and latent constructs, providing a solid foundation for subsequent data analysis and interpretation.

Table 3. Combined loadings and cross-loadings.

Combined Loadings and Cross-Loadings								
	GI	ES	IC	GMS	DGA	Type (a)	SE	*p* value
S1	0.96	0.118	0.011	−0.088	0.058	Formative	0.048	<0.001
S2	0.666	−0.631	0.295	1.694	−1.353	Formative	0.05	<0.001
A1	0.965	0.101	−0.099	−0.475	0.377	Formative	0.048	<0.001
A2	0.972	0.215	−0.116	−0.602	0.497	Formative	0.048	<0.001
ES1	0.745	0.864	0.011	−0.088	0.058	Reflective	0.049	<0.001
ES2	−2.407	0.675	0.138	0.078	−0.067	Reflective	0.05	<0.001
ES3	−0.837	0.686	−0.328	−1.092	0.891	Reflective	0.05	<0.001
ES4	0.983	0.719	0.29	1.652	−1.314	Reflective	0.05	<0.001
ES5	0.974	0.871	−0.099	−0.475	0.377	Reflective	0.049	<0.001
IC1	−0.003	−0.313	0.643	−1.296	1.619	Reflective	0.05	<0.001
IC2	0.8	−0.966	0.726	1.909	−1.638	Reflective	0.05	<0.001
IC3	1.031	−0.512	0.828	−0.622	0.358	Reflective	0.049	<0.001
IC4	−1.924	1.781	0.745	−0.05	−0.2	Reflective	0.05	<0.001
GMS1	−0.079	−0.354	0.339	0.715	−2.539	Reflective	0.05	<0.001
GMS2	0.962	0.23	−0.116	0.686	0.48	Reflective	0.05	<0.001
GMS3	1.439	−0.475	−0.209	0.63	3.371	Reflective	0.05	<0.001
GMS4	−2.036	0.532	−0.041	0.742	−0.862	Reflective	0.05	<0.001
GA1	−0.079	−0.354	0.339	3.103	0.561	Reflective	0.051	<0.001
GA2	0.962	0.23	−0.116	−0.597	0.575	Reflective	0.051	<0.001
GA3	1.439	−0.475	−0.209	−2.436	0.717	Reflective	0.05	<0.001
GA4	−2.036	0.532	−0.041	2.232	0.786	Reflective	0.049	<0.001
GA5	0.075	−0.014	0.074	−1.777	0.793	Reflective	0.049	<0.001

S = strategies, A = actions, ES = environmental sustainability, IC = innovation climate, GMS = green motivational strategies, GA = green abilities.

Table 4 presents the correlation statistics among the study's variables. It reveals noteworthy relationships between the latent constructs: green innovation (GI), environmental sustainability (ES), innovation climate (IC), green motivational strategies (GMS), and developing green abilities (DGA). The correlation between green innovation (GI) and environmental sustainability (ES) is notably strong, with a coefficient of 0.729, indicating a positive and significant association. This suggests that organizations implementing green innovation practices tend to exhibit higher levels of environmental sustainability. Similarly, the correlation between green innovation (GI) and innovation climate (IC) stands at 0.693, indicating a positive relationship. This suggests that organizations emphasizing green innovation also tend to foster a supportive innovation climate.

Table 4. Correlation Stats among Variables.

	GI	ES	IC	GMS	DGA
GI					
ES	0.729				
IC	0.693	0.764			
GMS	0.743	0.771	0.733		
DGA	0.621	0.662	0.72	0.749	

Green Innovation (GI), Environmental Sustainability (ES), Innovation Climate (IC), Green Motivational Strategies (GMS), and Developing Green Abilities (DGA).

Furthermore, the correlation between Green Innovation (GI) and Green Motivational Strategies (GMS) is 0.743, emphasizing a positive association. This implies that organizations emphasizing green innovation are more likely to implement motivational strategies that encourage environmentally responsible behaviors. The correlation between green innovation (GI) and developing green abilities (DGA) is 0.621, reflecting a positive relationship. This suggests that a propensity for green innovation aligns with the development of positive green abilities among individuals within organizations. additionally, the correlation between environmental sustainability (ES) and innovation climate (IC) is robust, with a coefficient of 0.764, underscoring their positive association. This signifies that organizations emphasizing environmental sustainability also tend to cultivate an innovation-supportive climate. Furthermore, the correlation between environmental sustainability (ES) and green motivational strategies (GMS) is 0.771, indicating a positive link. This implies that organizations with strong environmental sustainability efforts often implement motivational strategies to enhance sustainable practices.

The correlation between environmental sustainability (ES) and developing green abilities (DGA) is 0.662, highlighting their positive relationship. This suggests that as environmental sustainability initiatives advance, individuals within organizations tend to develop more positive green abilities. Moreover, the innovation climate (IC) and green motivational strategies (GMS) exhibit a correlation of 0.733, signifying their positive association. This suggests that organizations with an innovation-friendly climate also tend to implement motivational strategies that support green initiatives. Lastly, the correlation between innovation climate (IC) and developing green abilities (DGA) stands at 0.72, emphasizing their positive relationship. This suggests that a supportive innovation climate within organizations can contribute to the development of positive green abilities among individuals. In summary, Table 3 provides a comprehensive overview of the correlations among the study's key variables, revealing the interconnectedness of green innovation, environmental sustainability, innovation climate, green motivational strategies, and developing green abilities within the studied organizational context.

Table 5 presents a comprehensive evaluation of the model fit and various statistical indicators that assess the model's effectiveness in explaining the relationships among the latent constructs within the study. The average path coefficient (APC) is calculated at 0.697, demonstrating a strong relationship between the observed variables and their respective latent constructs ($p < 0.001$). This indicates that the model effectively captures the relationships proposed in the study. The average R-squared (ARS) and average adjusted R-squared (AARS) values are notably high at 1.382 and 1.389, respectively, further affirming the model's explanatory power ($p < 0.001$). These values suggest that the model accounts for a substantial proportion of the variance in the observed variables. Average block VIF (AVIF) and average full collinearity VIF (AFVIF) values, at 3.0328 and 4.2869, respectively, fall within acceptable ranges, signifying that multicollinearity concerns are adequately addressed in the model. This indicates that the variables included in the model are not highly correlated with each other, ensuring the reliability of the estimates.

Table 5. Model Fit.

Model Fit						
Average path coefficient	(APC) = 0.697				$p < 0.001$	
Average R-squared	(ARS) = 1.382				$p < 0.001$	
Average adjusted R-squared	(AARS) = 1.389				$p < 0.001$	
Average block VIF	(AVIF) = 3.0328	acceptable if ←5	ideally ←3.3			
Average full collinearity VIF	(AFVIF) = 4.2869	acceptable if ←5	ideally ←3.3			
Tenenhaus GoF	(GoF) = 0.985	small ≥ 0.1	medium ≥ 0.25	large ≥ 0.36		
Sympson's paradox ratio	(SPR) = 1.000	acceptable if ≥ 0.7		ideally = 1		
R-squared contribution ratio	(RSCR) = 1.000	acceptable if ≥ 0.9		ideally = 1		
Statistical suppression ratio	(SSR) = 1.000	acceptable if ≥ 0.7				
Nonlinear bivariate causality direction ratio	(NLBCDR) = 0.800	acceptable if ≥ 0.7				
R-squared coefficients						
GI	ES	IC	GMS	DGA	GMS×GI	DGA×GI
	0.702	0.562				
Q-squared coefficients						
GI	ES	IC	GMS	DGA	GMS×GI	DGA×GI
	0.909	0.557				

The Tenenhaus Goodness of Fit (GoF) score is impressively high at 0.985, demonstrating a strong fit for the model. This reflects the model's capability to explain and predict the relationships among the constructs effectively [47]. Sympson's paradox ratio (SPR), R-squared contribution ratio (RSCR), statistical suppression ratio (SSR), and nonlinear bivariate causality direction ratio (NLBCDR) all exhibit values well within acceptable ranges, indicating that the model does not suffer from issues of suppression or nonlinear causality. The R-squared coefficients for the individual latent constructs indicate the proportion of variance explained by the model. Notably, the R-squared coefficients for green innovation (GI), environmental sustainability (ES), and innovation climate (IC) are 0.702, 0.562, and 0.557, respectively, underlining the model's capability to explain a substantial portion of the variance in these constructs. Furthermore, the Q-squared coefficients for the latent constructs further emphasize the model's predictive ability, with green innovation (GI), environmental sustainability (ES), and innovation climate (IC) displaying values of 0.909, 0.557, and 0.557, respectively.

In summary, Table 5 showcases the robustness of the model in terms of fit, explanatory power, and predictive capability, providing strong evidence for the model's effectiveness in elucidating the relationships among the key constructs within the study.

Table 6 presents a comprehensive analysis of the direct relationships and moderation paths within the model, offering detailed insights into the total effects, the number of paths for total effects, standard errors for total effects, effect sizes for total effects, and *p*-values for total effects (see Figure 2). Beginning with the direct total effects, it becomes evident that the relationship between green innovation and environmental sustainability is notably strong, with a substantial total effect of 0.813. This signifies a robust and positive influence, indicating that organizations that embrace green innovation practices tend to exhibit higher levels of environmental sustainability. Similarly, the total effect between green innovation and innovation climate is noteworthy at 0.75, underscoring a significant and positive relationship. This implies that green innovation initiatives contribute significantly to the development of a conducive innovation climate within organizations. In terms of the number of paths for total effects, the analysis reveals that for environmental sustainability there exists a single path, indicating that green innovation directly impacts environmental sustainability. In contrast, for innovation climate, two paths are identified. One path originates from green innovation, while the other path emanates from environmental sustainability. This finding underscores the dual influence on the innovation climate, highlighting the importance of both green innovation and environmental sustainability in shaping the organizational innovation climate.

Table 6. Direct and Moderation Path Analysis.

			Direct				
			Total effects				
	GI	ES	IC	GMS	DGA	GMS×GI	DGA×GI
ES	0.813		0.23			−0.833	−0.86
IC	0.75						
			Number of paths for total effects				
ES	1						
IC	2		1			1	1
			Standard errors for total effects				
ES	0.049		0.054			0.049	0.049
IC	0.049						
			Effect sizes for total effects				
ES	0.757		0.178			0.619	0.648
IC	0.562						
			p values for total effects				
ES	<0.001		<0.001			<0.001	<0.001
IC	<0.001						

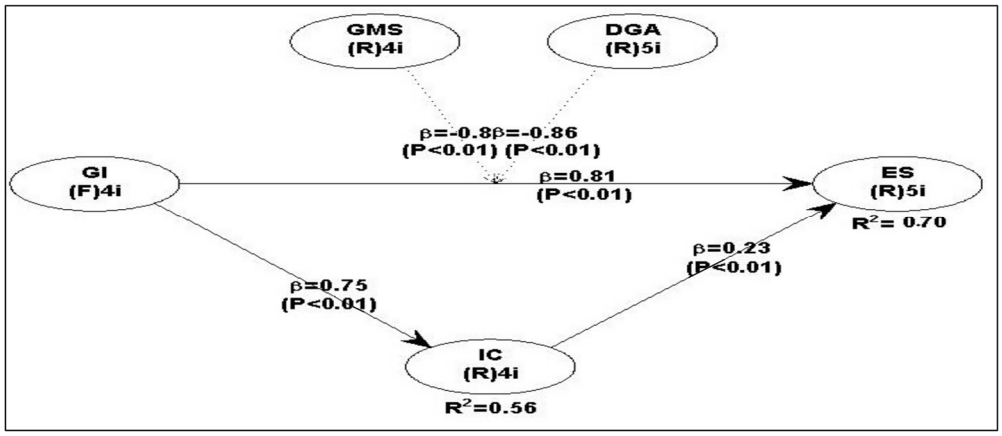

Figure 2. Path Analysis.

Standard errors for total effects are consistently low, with values ranging from 0.049 to 0.054. These low standard errors signify precise estimations of the total effects, indicating a high level of confidence in the results. Effect sizes for total effects provide insights into the magnitude of influence. For environmental sustainability, the effect size is substantial, measuring at 0.757, implying that green innovation has a noteworthy impact on environmental sustainability. Conversely, for innovation climate, the effect size is moderate, with a value of 0.562, suggesting that green innovation plays a moderately influential role in shaping the innovation climate. Furthermore, the *p*-values for total effects are highly significant across the board ($p < 0.001$). This statistical significance underscores the robustness of the relationships within the model, affirming the credibility of the findings. In summary, Table 5 provides an in-depth examination of the direct relationships and total effects between green innovation, environmental sustainability, and innovation climate. It highlights their significance and effect sizes, emphasizing the pivotal role of green innovation in fostering environmental sustainability and nurturing a supportive innovation climate within organizations.

Table 7 delves into the mediation path analysis, specifically examining the indirect effects for paths with two segments within the model. It provides valuable insights into these mediation relationships, including the number of paths with two segments, *p*-values of indirect effects, standard errors of indirect effects, and effect sizes of indirect effects (see Figure 3). In the context of the indirect effects for paths with two segments, the analysis reveals that the indirect effect of environmental sustainability mediating the relationship

between green innovation and other constructs is significant. Specifically, the indirect effect of environmental sustainability as a mediator is calculated at 0.172.

Table 7. Mediation Path Analysis.

Indirect Effects for Paths with 2 Segments					
	GI	ES	IC	GMS	DGA
ES	0.172				
Number of paths with 2 segments					
ES	1				
p values of indirect effects for paths with 2 segments					
SPP	<0.001				
Standard errors of indirect effects for paths with 2 segments					
SLE	0.038				
Effect sizes of indirect effects for paths with 2 segments					
SPP	0.16				

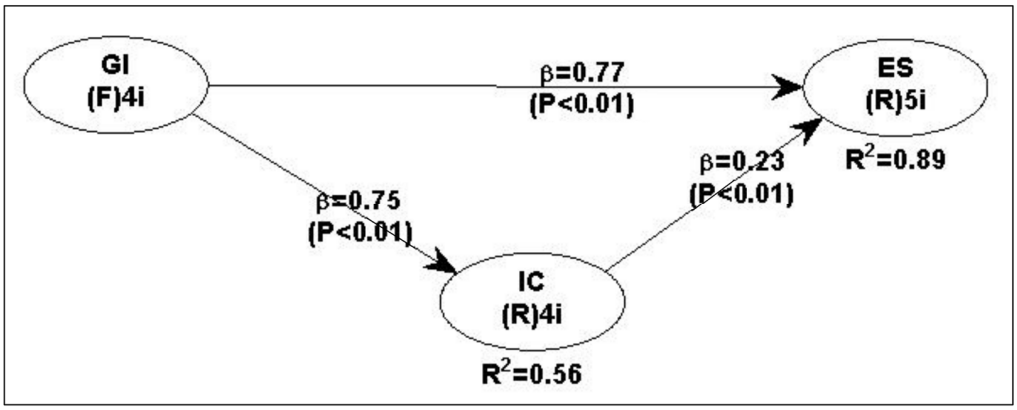

Figure 3. Mediation Analysis.

Regarding the number of paths with two segments, for environmental sustainability, there is one path with two segments, indicating that environmental sustainability acts as a mediator between green innovation and the other constructs in the model. The *p*-value associated with the indirect effect of environmental sustainability as a mediator is highly significant ($p < 0.001$), underscoring the robustness of the mediation relationship. Standard errors of the indirect effects are estimated at 0.038, indicating a relatively low level of uncertainty in these mediation relationships. Effect sizes for the indirect effects, as represented by the Sobel's test statistic (SPP), are calculated at 0.16, highlighting the magnitude of mediation. This suggests that the mediation effect of environmental sustainability in the relationship between green innovation and other key constructs in the study is moderate in size. In summary, Table 6 provides a detailed analysis of mediation pathways within the model, emphasizing the significance and effect size of the mediation effect of environmental sustainability in the relationships between green innovation and other constructs in the study.

6. Discussion

In this discussion chapter, the detailed analysis and interpretation of research results are presented, along with comparisons to existing literature to provide a comprehensive understanding of the study's findings. The first hypothesis posited that green innovation significantly affects environmental sustainability. The findings of the research provide empirical evidence in favor of the proposed hypothesis, demonstrating a significant and favorable correlation (total impact = 0.813, $p < 0.001$) between green innovation and the promotion of environmental sustainability. This discovery is in accordance with previous studies conducted in the realm of sustainability and innovation, which have continuously

underscored the favorable influence of green innovation on environmental results. The implementation of environmentally conscious practices, technologies, and processes inside industrial companies has the potential to decrease resource consumption, waste creation, and emissions, hence promoting improved environmental sustainability [41]. In the context of industrial firms, these findings hold considerable implications. Embracing green innovation not only aligns with global sustainability goals but can also lead to cost savings through resource efficiency, improved brand image, and increased competitiveness within eco-conscious markets [48].

The second hypothesis posited that green innovation significantly affects the innovation climate. The study results affirm this hypothesis, demonstrating a substantial and positive relationship (total effect = 0.75, $p < 0.001$) between green innovation and the innovation climate. This finding backs up previous research demonstrating the impact of green innovation as a generator of a positive innovation climate within firms [10]. Green innovation frequently develops a culture of creativity, openness to new ideas, and willingness to test ecologically friendly solutions. This implies that investments in green innovation can have a dual benefit for industrial firms: they not only contribute to environmental sustainability, but they also foster an environment conducive to innovation, potentially leading to the development of new products, processes, or services that can boost competitiveness and profitability.

The third hypothesis proposed that innovation climate significantly affects environmental sustainability. The study findings support this hypothesis, indicating a substantial and positive relationship between innovation climate and environmental sustainability. This outcome resonates with research suggesting that a supportive innovation climate can facilitate the implementation of sustainable practices and the integration of environmental considerations into decision-making processes [4]. When employees perceive an organization as innovative and forward-thinking, they are more likely to actively engage in sustainability initiatives. Within industrial firms, nurturing an innovation climate can be an effective strategy for promoting environmental sustainability. It encourages employees to generate eco-friendly solutions, fosters collaboration, and enhances adaptability, all of which are conducive to achieving sustainability goals.

The fourth hypothesis proposed that an innovation climate significantly mediates the relationship between green innovation and environmental sustainability. The study confirms this hypothesis, highlighting the mediating role of an innovation climate in connecting green innovation and environmental sustainability. This finding aligns with the literature on the mediating role of an innovation climate in the context of sustainability initiatives [3]. An innovation-friendly climate serves as a conduit through which green innovation practices can lead to enhanced environmental sustainability. Organizations that prioritize green innovation create an environment where employees are more inclined to embrace sustainability practices. For industrial firms, recognizing this mediation effect underscores the importance of fostering a culture of innovation as a means to bridge the gap between green innovation efforts and their ultimate impact on environmental sustainability.

The fifth hypothesis proposed that developing green abilities significantly moderates the relationship between green innovation and environmental sustainability. The study findings found significant support for this hypothesis. This outcome diverges from some prior research, which has suggested that the attitudes and values of employees play a moderating role in influencing the effectiveness of green innovation initiatives [42]. Nonetheless, the moderation effect may imply that in the context of industrial firms, the direct relationship between green innovation and environmental sustainability gets more robust in the presence of the moderating effect, with respect of individual attitudes. The final hypothesis posited that green motivational strategies significantly moderate the relationship between green innovation and environmental sustainability. The study findings provide support for this hypothesis, revealing a moderating effect of green motivational strategies. This finding aligns with research emphasizing the importance of motivation and incentives in driving eco-friendly behaviors and practices within organizations [4]. When industrial

firms employ effective green motivational strategies, they can amplify the positive impact of green innovation on environmental sustainability.

In practical terms, this implies that industrial firms should invest in designing and implementing motivational strategies that encourage employees to actively engage in green innovation initiatives. Such strategies may include rewards, recognition, and career development opportunities linked to sustainability achievements. In conclusion, this discussion has examined each hypothesis in detail, comparing the findings with existing literature and exploring their implications within the context of industrial firms. The study's results confirm the critical role of green innovation in enhancing both environmental sustainability and the innovation climate within organizations. Additionally, it underscores the mediating role of the innovation climate in linking green innovation to environmental sustainability. The study also highlights the moderating influence of green motivational strategies, which can enhance the effectiveness of green innovation efforts. These findings provide valuable insights for industrial firms seeking to integrate sustainability practices into their operations. By fostering green innovation, nurturing an innovation-friendly climate, and implementing effective motivational strategies, organizations can not only advance their environmental sustainability goals but also strengthen their overall competitive position in an increasingly eco-conscious market landscape.

7. Implications of the Study

This research carries several practical implications for industrial firms and organizations aiming to improve their environmental sustainability while fostering innovation. The study underscores the importance of embracing green innovation as a means to enhance both environmental sustainability and the innovation climate. Industrial firms should consider investing in sustainable research and development initiatives, eco-friendly technologies, and processes that not only reduce their ecological footprint but also stimulate innovation. Organizations can actively cultivate an innovation-friendly climate by encouraging creativity, open communication, and experimentation. Such a climate not only supports green innovation but also facilitates the development of innovative solutions, products, and services. Employees should promote a culture that values new ideas and encourages employees to contribute to sustainable practices. The study highlights the role of green motivational strategies in moderating the relationship between green innovation and environmental sustainability. Industrial firms can implement motivational programs, rewards, and incentives to encourage employees to actively participate in sustainability initiatives. This includes recognizing and rewarding sustainable behaviors, setting clear sustainability goals, and aligning employee career development with sustainability achievements. Organizations should consider investing in training and education programs to raise awareness and enhance the environmental knowledge of their workforce. By equipping employees with the necessary skills and understanding, firms can ensure that green innovation practices are effectively integrated into daily operations.

This research also contributes to the theoretical landscape of sustainability, innovation, and organizational behavior. The study integrates multiple constructs, including green innovation, innovation climate, environmental sustainability, green abilities, and motivational strategies. This holistic approach provides a comprehensive view of how these elements interact within the context of industrial firms, contributing to a more nuanced understanding of the relationships. By demonstrating the mediating role of innovation climate and the moderating influence of green motivational strategies, this research extends existing theoretical frameworks. It sheds light on how these factors operate in tandem to influence the impact of green innovation on environmental sustainability, enriching the literature on mediation and moderation effects in sustainability research. The study applies well-established theories, such as the Innovation Diffusion Theory and Environmental Sustainability Theory, to the context of industrial firms. This practical application of theories enhances their relevance and utility in addressing real-world sustainability challenges and reinforces their validity in diverse organizational settings. The findings

offer valuable insights for employees of the organization, especially for managerial decision-making, helping leaders make informed choices regarding green innovation initiatives, innovation climate enhancement, and motivational strategies. These insights bridge the gap between theory and practice, facilitating the implementation of sustainable practices in organizations.

In conclusion, this research not only provides practical guidance for industrial firms but also enriches the theoretical foundations of sustainability and innovation by elucidating the complex relationships among key constructs. It offers a roadmap for organizations seeking to simultaneously advance their environmental sustainability goals and foster a culture of innovation, ultimately contributing to a more sustainable and innovative future.

8. Limitations and Future Research Directions

Although this study has yielded significant insights, it is crucial to recognize limitations that may affect the interpretation and practicality of the results. The study's sample was limited in scope, since it primarily targeted employees working in the oil and gas, minerals, and mining sectors specifically within the Kingdom of Saudi Arabia. The limited scope of the sample used in this study may restrict the applicability of the research results to a broader array of sectors and geographic areas. The specific characteristics, challenges, and regulations of these sectors could also influence the observed relationships and may not fully represent the dynamics in other industries. Secondly, the research design employed cross-sectional data collection, providing a snapshot of the relationships at a particular point in time. While this approach is valuable for examining associations, it does not capture the dynamic nature of sustainability and innovation efforts. Future research could benefit from longitudinal or time-series data to trace the evolution of these relationships and better understand the causal mechanisms at play. A potential concern in this study is common method bias, which arises from relying solely on self-reported survey data. While self-report surveys are commonly used in research, they may introduce biases due to respondents' subjectivity and shared method variance. Future research could mitigate this limitation by incorporating data from multiple sources, such as employees, customers, or objective performance metrics, to provide a more comprehensive and balanced perspective. Lastly, while the study utilized standardized measurement scales, it is essential to recognize that these scales may not capture the full complexity and context-specific nuances of green innovation, innovation climate, and environmental sustainability within the industrial sector. Future research might explore the development of customized measurement tools tailored to the specificities of this industry, potentially providing a more accurate representation of the constructs under investigation. In summary, these limitations should be considered when interpreting the findings and may guide future research endeavors aimed at addressing these issues to enhance the robustness and applicability of research in the field of green innovation, innovation climate, and environmental sustainability in industrial firms.

9. Conclusions

In conclusion, this research has contributed valuable insights into the interplay between green innovation, innovation climate, and environmental sustainability within the context of industrial firms. The findings affirm the significant and positive relationships between green innovation and both environmental sustainability and the innovation climate. Additionally, the study highlights the mediating role of the innovation climate and the moderating effect of green motivational strategies, shedding light on the complex dynamics that influence sustainability outcomes. While the research has advanced our understanding of these critical relationships, it is essential to acknowledge its limitations, including sample specificity, cross-sectional data, potential common method bias, and measurement scale considerations. These limitations provide opportunities for future research to refine and expand upon the findings, particularly by incorporating more diverse samples, longitudinal data, and advanced measurement techniques. Overall, this study underscores the

pivotal role of green innovation in driving environmental sustainability and fostering innovation within industrial firms. The practical and theoretical implications derived from this research offer valuable guidance for organizations aiming to integrate sustainability practices into their operations and cultivate a culture of innovation. By addressing these challenges and opportunities, businesses can move closer to achieving both their environmental sustainability goals and their aspirations for innovation, ultimately contributing to a more sustainable and innovative future.

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Appendix A

Questionnaire Items
Green Innovation (4 items):
1. Our organization actively seeks innovative strategies to reduce its environmental impact.
2. Our organization encourages employees to come up with creative green solutions.
3. Our organization implements environmentally friendly practices in product development.
4. Our organization regularly adopts new environmentally sustainable technologies.
Innovation Climate (5 items):
5. Our workplace fosters an environment where employees feel encouraged to propose new ideas.
6. There is open communication in our organization, which promotes the sharing of innovative thoughts.
7. Employees have access to the necessary resources to support their innovative initiatives.
8. Our organization values creativity and rewards innovative contributions.
9. Decision-making processes in our organization encourage innovation.
Environmental Sustainability (5 items):
10. Our organization has implemented practices to reduce its carbon footprint.
11. We have clear sustainability goals and objectives in our organization.
12. Our organization actively monitors and reports on its environmental performance.
13. We consider the environmental impact in our decision-making processes.
14. Our organization is committed to reducing waste and conserving natural resources.
Developing Green Abilities (5 items):
15. Our organization offers training programs to develop employees' green skills.
16. I feel confident in my ability to contribute to our organization's environmental sustainability efforts.
17. I believe that my organization provides opportunities for me to enhance my green knowledge.
18. Our organization supports continuous learning and improvement in green practices.
19. I actively seek opportunities to develop my skills in environmentally sustainable practices.
Green Motivational Strategies (4 items):
20. Our organization provides incentives to motivate employees to participate in green initiatives.
21. I feel motivated to contribute to our organization's environmental sustainability goals.
22. We receive recognition and rewards for our green achievements in our organization.
23. Our organization creates a supportive environment that encourages green behavior.

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