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Cultivating a Greener Future: Unveiling the Mechanism for Embracing Green Innovation in the Supply Chain

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Abstract:- The purpose of this study is to investigate the impacts of organizational support, knowledge sharing, competitive pressure, government policy, relative advantage, and compatibility on the adoption intention of green supply chain innovation. A total of 205 valid questionnaires were collected from managerial professionals operating within the manufacturing sector of the supply chain in China. The findings suggest that factors such as organizational support, knowledge sharing, competitive pressure, government policy, relative advantage, and compatibility, collectively contribute to the adoption intention of supply chain in green innovation by addressing various aspects of organizational, environmental, and competitive contexts. The implications of these identified patterns are further elaborated.

Keywords*: supply chain, green innovation, organizational support, knowledge sharing, competitive pressure, adoption intention*

1. Introduction

Within the realm of Green Innovation, an increasing number of scholars are directing their attention towards the intricate links within enterprise supply chains. In advancing the Green Innovation strategy within the supply chain, there is a compelling need to broaden the primary research scope beyond the prevailing innovation system, reaching out to front-line scientific researchers. This expansion aims to establish a micro-humanistic foundation for the operationalization of Green Innovation activities.

While existing studies have delved into the factors influencing corporate innovation intentions, there exists a notable research gap concerning the trajectory of adopting green innovation within the supply chain. The current body of research falls short in comprehensively exploring the dynamics of supply chain green innovation, warranting a deeper investigation into the driving factors that propel innovation throughout the entire supply chain.

It is imperative to elucidate the specific aspects that contribute to the existing gap in supply chain green innovation research. A more nuanced examination of the influencing factors can shed light on the intricacies of the adoption process within the supply chain. For instance, considering the role of collaboration among stakeholders in the supply chain—ranging from suppliers to manufacturers and distributors—can provide valuable insights into the dynamics of green innovation adoption.

Additionally, it is crucial to underscore the necessity of examining concrete examples and case studies within the context of supply chain green innovation. By incorporating real-world instances of successful or challenging adoption scenarios, researchers can derive practical insights that go beyond theoretical frameworks. This approach not only enriches the academic discourse but also provides a pragmatic foundation for understanding the complexities inherent in the adoption intention of green innovation in the supply chain.

2. Literature Review

A. Green Innovation

The existing body of research on Green Innovation spans multiple dimensions, encompassing not only technical aspects at the product level but also broader considerations related to processes, management, and services. At the technical level, scholars have explored green product innovation, delving into areas such as green product design, the utilization of eco-friendly materials, and sustainable packaging [1,2]. Complementary research has also extended to process innovation, examining elements like green technology, eco-friendly equipment, and sustainable recycling practices [3,4].

Moreover, non-technical dimensions of Green Innovation have been under scrutiny, encompassing management-related innovations. This includes institutional changes and the establishment of environmental assessment and management systems, highlighting the broader organizational shifts required to foster green practices [1]. The spectrum of Green Innovation further extends to services, with a focus on low-energy services. This area of research investigates the development and implementation of services that contribute to energy conservation and environmental sustainability [5]- [7].

From the vantage point of the supply chain, Green Innovation extends beyond product and process considerations to encompass the construction of a green supply chain network. Scholars have explored the intricate dynamics involved in establishing and optimizing supply chain networks with a keen focus on environmental sustainability [8]. This holistic perspective emphasizes the interconnectedness of various elements within the supply chain, underscoring the importance of a comprehensive approach to Green Innovation that addresses both technical and non-technical dimensions across the entire supply chain network.

B. Organizational Support

Eisenberger introduced the concepts of Organizational Support Theory (OST) and Perceived Organizational Support (POS) rooted in social exchange theory and the principle of reciprocity. Organizational support stands as the focal point within Organizational Support Theory. Eisenberger et al. [9] defined organizational support as an assessment made by an organization regarding its employees' contributions and its level of concern for their well-being. This definition facilitates a comprehensive and holistic comprehension of organizational support.

McMillan [10] further augmented and expanded Eisenberger's OST through an array of empirical studies. McMillan asserted that, without substantial tool support, employees lack the necessary antecedents and foundations to fulfill their work responsibilities effectively. The provision of adequate tools is seen as crucial for ensuring the efficient completion of work tasks.

Organizational Support Theory, as developed by Eisenberger and extended by McMillan, underscores the importance of reciprocal relationships within organizations. It posits that when employees perceive genuine support from their organization, both in terms of acknowledgment for their contributions and a commitment to their well-being, it fosters a positive exchange dynamic. Moreover, McMillan emphasizes the instrumental role of tools and resources in facilitating employees' ability to carry out their work successfully. This framework encourages organizations to not only recognize the efforts of their employees but also to provide the necessary resources for them to excel in their roles.

C. Knowledge Sharing

Knowledge sharing, as a fundamental aspect of organizational dynamics, pertains to the systematic exchange of information among employees within an organizational framework [11]. It goes beyond mere transmission of data, encapsulating the nuanced ways in which employees actively contribute to the processes of knowledge creation and application within the organizational context [12]. This denotes a deliberate and strategic engagement in the dissemination and utilization of knowledge resources for the collective benefit of the organization.

Moreover, knowledge sharing can be conceptualized as a cultural phenomenon within the social fabric of an organization, fostering interactive exchanges among employees. This encompasses the fluid exchange of employees' knowledge, experiences, and skills across the entire department or organization, contributing to the formation of a shared knowledge environment [13]. It signifies a collective ethos that encourages openness, collaboration, and the mutual enrichment of intellectual assets.

The multifaceted nature of knowledge sharing is underscored by the diverse perspectives through which scholars have defined and examined this concept. Some have approached it from a technological standpoint, emphasizing the role of digital platforms and communication tools in facilitating information dissemination. Others have delved into the psychological and cultural dimensions, exploring the factors that influence individuals' willingness to share knowledge and the impact of organizational culture on fostering a conducive knowledge-sharing environment.

D. Competitive Pressure

Competitive pressure has been recognized as a significant motivator in the initial stages of technology adoption research [14]-[16]. Zhu and Kraemer [17] provide a defined perspective, characterizing competitive pressure as the extent to which a firm perceives pressure from industry competitors. There is a consensus in the literature that industry competition can exert a positive influence on the adoption of Information Technology (IT), particularly when the technology in question directly impacts competition, and the adoption of new technologies becomes a strategic imperative in market competition [18].

This principle holds true in the realm of information systems within the Supply Chain. The adoption of information systems plays a transformative role, enabling firms to reshape the competitive landscape by influencing competition rules, industry structure, and outperforming competitors [19]. The competitive dynamics within an industry serve as a catalyst for the adoption of information systems in the Supply Chain.

To illustrate, consider a scenario where companies in a industry are increasingly integrating advanced information systems into their supply chain operations. This competitive environment, driven by the need for efficiency, real-time information, and enhanced customer satisfaction, compels other firms to adopt similar technologies to remain competitive. The pressure emanates not only from the desire to keep pace with industry norms but also from the strategic imperative of gaining a competitive edge in the market.

Moreover, the influence of competitive pressure on technology adoption is particularly pronounced when the technology in question represents a strategic necessity for firms to thrive in the competitive market landscape. In such cases, the competitive environment acts as a compelling force propelling firms to embrace technological advancements to secure their position and viability in the marketplace.

E. Government Policy

Government policy, as articulated by Kim et al. [20], refers to the level of support provided by authoritative institutions, such as governments and government agencies, to foster the adoption of innovations within organizations. This support manifests in the form of government regulation and policy encouragement. Government regulation involves the enhancement of pertinent laws and regulations pertaining to environmental protection and industry standards. This includes stringent penalties for violations of environmental regulations and swift responses to publicized environmental infractions. Policy encouragement, on the other hand, entails the design and formulation of preferential policies for environmental protection. Enterprises that align with these policies can enjoy corresponding incentives or subsidies. It is posited that government preferential policies can substantially enhance the economic benefits of enterprises [21].

Additionally, Lv et al. [22] assert that government policies, particularly those related to tax cuts, low-interest loans, and intellectual property regulations, can contribute to the enhancement of competitive advantage and the promotion of corporate performance. The impact of these policies is particularly pronounced in large corporations compared to small and medium-sized enterprises that may lack the resources and financial support to leverage such incentives. The influence of government policies on organizational performance underscores the significance of the regulatory and incentivizing role that governments play in shaping the business landscape. The interplay between government policies and corporate activities is instrumental in steering organizations towards sustainable and innovative practices, with implications extending beyond economic benefits to encompass environmental and societal considerations.

F. Relative Advantage

Relative Advantage, as conceptualized by Rogers [23], denotes the extent to which an innovation is perceived as superior to preceding ideas. The perception of advantages associated with technological innovations is, to a certain extent, shaped by users [24]. For instance, in the context of small and medium-sized businesses, owners' belief in the utility of IT innovations and their potential to enhance work performance correlates positively with their willingness to adopt and utilize such innovations [25].

Rogers [26] further elaborates that Relative Advantage specifically signifies the degree of superiority of innovative products over their predecessors. Consumer adoption tendencies are influenced by the perceived extent of improvement offered by innovative products. In the realm of low-carbon innovations, Relative Advantages encompass economic cost, benefits, and convenience, delineating products that surpass their counterparts in these dimensions [27].

To illustrate, consider the introduction of energy-efficient appliances in the consumer electronics market. If consumers perceive these appliances as offering cost savings, environmental benefits, and user-friendly features compared to traditional counterparts, the Relative Advantage is high. Consequently, consumers are more likely to adopt and integrate these low-carbon innovations into their households.

Moreover, the notion of Relative Advantage extends beyond individual perceptions to influence organizational decisions. In a corporate setting, the adoption of innovative technologies, such as advanced manufacturing processes or sustainable supply chain practices, may be driven by the perceived advantages in terms of efficiency, cost-effectiveness, and overall performance.

G. Compatibility

Compatibility, as delineated by Rogers [28], refers to the extent to which an innovation is perceived to align with existing values, past experiences, and the needs of potential adopters. The heightened compatibility between an innovation and the needs of adopters facilitates seamless integration of technology across organizations and business functions. This alignment holds the potential for multiple benefits, such as the reduction of time and costs, as users are spared the need to dismantle expensive infrastructure when embracing new technologies [29].

The concept of compatibility plays a pivotal role in the successful adoption of innovations. When an innovation resonates with the prevailing values and requirements of potential adopters, it is more likely to be embraced and integrated into existing processes. For instance, consider the implementation of a new project management software in a business setting. If the software is compatible with the current workflow, user habits, and organizational objectives, its adoption is likely to be smoother and more effective.

Conversely, the presence of incompatibility between the characteristics of an innovation and the needs and business processes of potential adopters emerges as a significant barrier to adoption [15]. For example, introducing a new communication tool that is incompatible with existing platforms and requires a complete overhaul of communication practices may face resistance due to the disruption it poses to established workflows.

H. Adoption Intention

Technology adoption, as defined by Khasawneh [30], encompasses the initial use or acceptance of a new technology or product. Positioned as a voluntary individual behavior [31], the adoption of technology is elucidated through various theories and models, such as the Rational Action Theory (TRA) [32], Innovation Diffusion Theory (IDT) [28], the Technology Acceptance Model (TAM) [33], the Technology-Organization-Environment (TOE) framework [34], and the Unified Theory of Technology Acceptance and Use (UTAUT) [35].

At the individual level, TRA, TAM, and UTAUT are instrumental in understanding the factors that influence an individual's decision to adopt a new technology. TRA emphasizes the role of rational actions and behavioral intentions, TAM focuses on the perceived ease of use and usefulness of technology, while UTAUT integrates various determinants, including performance expectancy, effort expectancy, social influence, and facilitating conditions.

Conversely, when analyzing technology adoption from an organizational perspective, IDT and the TOE framework come into play. IDT explores how innovations diffuse within organizations, emphasizing factors like communication channels, social systems, and the innovation-decision process. The TOE framework takes a broader view, considering the interplay of technological, organizational, and environmental factors in shaping adoption decisions within organizations.

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3. Research Methodology

A. Sample

Out of the 217 questionnaires from managerial professionals operating within the manufacturing sector of the supply chain in China were collected, 205 responses were valid for data analysis.

B. Instrument

Each item within the constructs is assessed using a 7-point Likert scale. The number of the survey items for each construct is presented in Table 1.

C. Reliability and convergent validity

In Table 1, all constructs exhibit strong composite reliability and AVE, meeting recommended standards [36]-[38]. The composite reliabilities are in the range of 0.846 to 0.923, and the convergent validity is acceptable.

Table 1 Means, S.D, CR, AVE of each construct

Construct	Item	Mean	Std Dev	Std.	CR	AVE
OS	OS01	5.57	1.14	0.858	0.872	0.631
	OS02	5.83	1.17	0.766		
	OS03	5.64	1.25	0.738		
	OS04	5.82	1.21	0.809		
KS	KS01	5.73	1.14	0.785	0.867	0.568
	KS02	5.81	1.20	0.704		
	KS03	5.85	1.17	0.761		
	KS04	5.69	1.30	0.684		
	KS05	5.76	1.15	0.825		
CP	CP01	5.51	1.21	0.947	0.861	0.676
	CP02	5.72	1.42	0.776		
	CP03	5.52	1.49	0.727		
GP	GP01	5.00	1.66	0.872	0.887	0.725
	GP02	4.72	1.57	0.827		
	GP03	4.83	1.68	0.854		
RA	RA01	6.11	1.22	0.776	0.856	0.599
	RA02	5.98	1.39	0.861		
	RA03	5.98	1.37	0.785		
	RA04	6.09	1.32	0.662		
CO	CO01	6.10	1.35	0.879	0.923	0.75
	CO02	5.81	1.58	0.824		
	CO03	5.98	1.49	0.820		
	CO04	6.02	1.41	0.935		
AI	AI01	5.49	1.54	0.860	0.846	0.648
	AI02	5.76	1.50	0.815		
	AI03	5.91	1.49	0.734		

Std., Standardized factor loadings; CR, Composite Reliability; AVE, Average Variance Extracted. OS, Organizational Support; KS, Knowledge Sharing; CP, Competitive Pressure; GP, Government Policy; RA, Relative Advantage; CO, Compatibility; AI, Adoption Intention

D. Discriminant validity

Discriminant validity, assessed following Fornell and Larcker's [37] method, confirms that all AVE values exceed correlation coefficients (see Table 2), demonstrating strong discriminant validity among constructs.

Table 2. Results of discriminant validity by AVE.

	AVE	OS	KS	CP	GP	RA	CO	AI
OS	0.631	**0.794**						
KS	0.568	0.356	**0.754**					
CP	0.676	0.228	0.145	**0.822**				
GP	0.725	0.113	0.248	0.474	**0.851**			
RA	0.599	-0.016	0.002	0.174	0.160	**0.774**		
CO	0.750	0.144	0.064	0.246	0.116	0.580	**0.866**	
AI	0.648	0.441	0.337	0.553	0.406	0.498	0.635	**0.805**

Note1: The items on the diagonal on bold represent the square roots of the AVE; off-diagonal elements are the correlation estimates.

Note2: OS, Organizational Support; KS, Knowledge Sharing; CP, Competitive Pressure; GP, Government Policy; RA, Relative Advantage; CO, Compatibility; AI, Adoption Intention

4. Results

A. Sample profile

The research encompasses a sample size of 205 individuals. The sample a majority of female (54.63%), as shown in the Table 3.

Table 3 Sample profile

Variable	Value Label		Frequency	Valid Percent
Gender	1.	Male	93	45.37
	2.	Female	112	54.63
Age	1.	30 or under	34	16.59
	2.	31-35	113	55.12
	3.	36-40	38	18.54
	4.	over 41	20	9.76
Education	1.	3-year College or under	7	3.41
	2.	4-year University degree	145	70.73
	3.	Graduate school	53	25.85
	Total		205	100

B. Model fit

Tiffany and Schumacker [39] recommend reporting nine widely accepted fitness metrics were reported to assess model fit. A good model fit typically results in a chi-square value/degrees of freedom ratio below 3. Additionally, Hu and Bentler [40] recommend evaluating each fitness metric independently and simultaneously controlling for type I errors with more stringent model fit metrics, such as the Comparative Fit Index (CFI) > 0.90, Standardized Root Mean Square Residual (SRMR) < 0.08, and Root Mean Square Error of Approximation (RMSEA) < 0.08.

During SEM analysis, model estimation often leads to an increase in the chi-square value, potentially affecting the model's fit. To address this, we corrected the chi-square value using the Bollen-Stine bootstrap p-value chi-square correction test [41]. The corrected chi-square value (χ^2) indicates that the model fit is 329.968, with 278 degrees of freedom, resulting in a chi-square to degrees of freedom ratio (χ^2/df) of 1.187. Moreover, the Tucker-Lewis Index (TLI) value is 0.980, the CFI value is 0.983, all exceeding the 0.9 threshold. The Goodness of Fit Index (GFI) value is 0.904, and the Adjusted Goodness of Fit Index (AGFI) value is 0.887, all exceeding the 0.8 threshold. Furthermore, the RMSEA value is 0.038, and the SRMR value is 0.041, both falling below the 0.08 standard. These results collectively indicate a strong degree of model fit. Table 4 presents the goodness-of-fit metrics for the models analyzed in this study.

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Table 4 Model fit

Model fit	Criteria	Model fit of research model	Model fit of Bollen-Stine
MLχ^2	The small the better	358.596	329.968
DF	The large the better	278	278
Normed Chi-sqr (χ^2/DF)	1<χ^2/DF<3	1.290	1.187
RMSEA	<0.08	0.038	0.038
SRMR	<0.08	0.041	0.041
TLI (NNFI)	>0.9	0.970	0.980
CFI	>0.9	0.974	0.983
GFI	>0.8	0.886	0.904
AGFI	>0.8	0.856	0.887

C. Path analysis

In Table 5, the path analysis results demonstrate significant associations among the constructs. OS (b=0.350, $p < 0.001$), KS (b=0.219, $p < 0.05$), CP (b=0.150, $p < 0.05$), GP (b=0.258, $p < 0.001$), RA (b=0.296, $p < 0.01$) and CO (b=0.427, $p < 0.001$) significantly affected AI. The combined influence of these values explained 71.9% of the variance of AI.

Table 5. Regression coefficient

DV	IV	Unstd	S.E.	Unstd./S.E.	*p*-value	Std.	R^2
AI	OS	0.350	0.082	4.249	0.000	0.258	0.719
	KS	0.219	0.089	2.471	0.013	0.147	
	CP	0.150	0.072	2.072	0.038	0.129	
	GP	0.258	0.060	4.299	0.000	0.281	
	RA	0.296	0.099	3.004	0.003	0.211	
	CO	0.427	0.079	5.427	0.000	0.382	

Note: OS, Organizational Support; KS, Knowledge Sharing; CP, Competitive Pressure; GP, Government Policy; RA, Relative Advantage; CO, Compatibility; AI, Adoption Intention

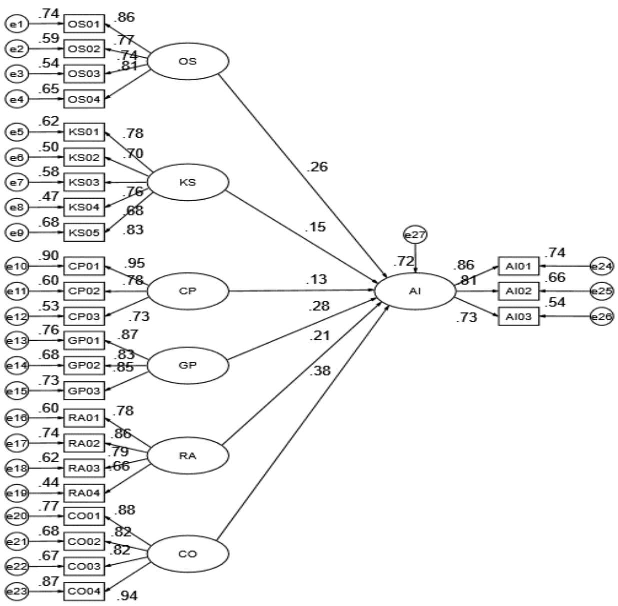

Figure 2. SEM model

Note: OS, Organizational Support; KS, Knowledge Sharing; CP, Competitive Pressure; GP, Government Policy; RA, Relative Advantage; CO, Compatibility; AI, Adoption Intention

5. Conclusions

All independent variables, naming organizational support, knowledge sharing, competitive pressure, government policy, relative advantage, and compatibility, have direct and significant impacts on the adoption intention of green innovation of supply chain.

Organizational support refers to the endorsement and commitment of top management and other organizational members to green innovation initiatives. When an organization actively supports and promotes green practices within its supply chain, it sends a clear signal that sustainability is a priority. Employees are more likely to adopt green innovation practices when they perceive strong organizational support. Support can manifest in resource allocation, training programs, and the integration of sustainability goals into the overall corporate strategy.

Knowledge sharing involves the exchange of information and expertise related to green innovation practices among different stakeholders within the supply chain. It includes sharing best practices, lessons learned, and technological advancements. Effective knowledge sharing facilitates learning and adaptation, enabling supply chain actors to stay informed about green technologies and practices. This, in turn, enhances the likelihood of adoption as organizations can leverage shared knowledge to overcome challenges and implement successful green innovations.

Competitive pressure refers to the influence exerted by market dynamics and the actions of rival companies. As sustainability becomes a key differentiator in the business landscape, organizations may feel compelled to adopt green innovations to maintain or improve their competitive position. The fear of falling behind competitors or losing market share can drive organizations to embrace green innovation within their supply chains. It acts as a motivator for companies to continually improve and align their practices with industry standards.

Government policies and regulations play a significant role in shaping the business environment. Policies that encourage or mandate environmentally friendly practices can greatly impact the adoption of green innovation in supply chains. Clear and supportive government policies provide a regulatory framework that guides organizations toward sustainable practices. Incentives, subsidies, or penalties can directly influence the adoption intention by aligning organizational goals with broader societal and environmental objectives.

Relative advantage refers to the perceived benefits of adopting green innovation compared to traditional practices. This includes improvements in efficiency, cost savings, enhanced reputation, and reduced environmental impact. Organizations are more likely to adopt green innovations when they believe that the benefits outweigh the costs. Demonstrating the competitive advantages and positive outcomes associated with sustainability practices encourages adoption among supply chain participants.

Compatibility assesses how well green innovations fit with existing organizational structures, processes, and values. If these innovations align seamlessly with current practices, they are more likely to be adopted. Green innovations that are compatible with an organization's existing operations are easier to integrate. Compatibility reduces resistance to change, making it more likely that supply chain actors will adopt and implement green practices without disrupting the overall workflow.

In summary, these factors collectively contribute to the adoption intention of supply chain in green innovation by addressing various aspects of organizational, environmental, and competitive contexts. The interaction of these elements shapes a supportive environment for the integration of sustainable and innovative practices within the supply chain.

6. Implications

The implications derived from the above findings are multifaceted and can guide organizations, policymakers, and other stakeholders toward fostering sustainable practices within supply chains.

Organizations should prioritize and actively support green innovation within their supply chains as a strategic initiative. This involves committing resources, aligning sustainability goals with corporate strategies, and fostering a culture that values environmental responsibility. Implement training programs, allocate resources for sustainable initiatives, and integrate green goals into the organization's mission and vision.

Facilitating effective knowledge sharing is crucial for staying informed about advancements in green technologies and best practices. Organizations should invest in platforms and processes that encourage the exchange of information and expertise. Establish knowledge-sharing platforms, organize training sessions, and create collaborative spaces for stakeholders to share experiences and innovations.

Recognizing the influence of competitive pressures, organizations should proactively embrace green innovations to maintain or improve their competitive positions. Regularly assess market trends, monitor competitors' sustainability initiatives, and continually strive for improvements to stay ahead in the competitive landscape.

Organizations should engage in advocacy efforts to promote and support government policies that encourage green innovation. Collaborative efforts with policymakers can create an environment conducive to sustainable supply chain practices. Participate in industry associations, engage with policymakers, and contribute to discussions on the development of supportive environmental regulations.

Organizations should effectively communicate the relative advantages of adopting green innovations, emphasizing benefits such as cost savings, efficiency improvements, enhanced reputation, and reduced environmental impact. Develop clear communication strategies to convey the positive outcomes associated with sustainability practices to both internal and external stakeholders.

Recognizing the importance of compatibility, organizations should strive to minimize resistance to change by ensuring that green innovations align with existing structures, processes, and values. Conduct thorough assessments of the compatibility of green innovations, involve key stakeholders in the decision-making process, and address concerns to minimize resistance.

The business environment, technologies, and regulations are dynamic. Organizations should continuously monitor changes, reassess their strategies, and adapt their green innovation practices accordingly. Establish mechanisms for ongoing monitoring, regularly review and update sustainability strategies, and stay agile in responding to emerging trends.

In conclude, the implications suggest a holistic approach that involves strategic commitment, collaboration, communication, and adaptability. Organizations that actively engage with these implications are more likely to create sustainable supply chains that align with environmental goals and societal expectations.

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