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The Strategic Role of Social Networks in Driving Green Innovation

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Abstract
Present research explores the strategic role of social networks in nurturing green innovation within the industrial sector of Pakistan. This quantitative study was conducted in Punjab Province using a stratified random sampling approach to capture industrial variation across four districts: Lahore, Sialkot, Gujranwala, and Faisalabad, with each contributing 109 respondents for a total sample of 436 participants drawn from industrial units and professionals including owners, managers, engineers, production in-charges, and sustainability managers in sectors such as textiles, sports goods, surgical instruments, and leather products. One eligible respondent from each firm was randomly selected to represent top management, technical staff, and environmental or sustainability specialists. Data were collected through a structured questionnaire developed in line with research objectives and analyzed using SPSS. The findings revealed that social capital significantly drives green innovation, with social networks supporting knowledge sharing, collaboration, and the adoption of sustainable practices, as most respondents (78–97%) agreed on their role in enhancing awareness, learning, and eco-friendly practices. Elements such as social participation, trust, reciprocity, civic engagement, cohesion, and collective action were found to strongly facilitate collaboration and implementation of green practices (80% agreement). Moreover, knowledge sharing and connected networks promoted innovation and adoption of eco-friendly technologies, while organizational initiatives such as sustainable product design, cleaner production, and environmental certifications were reinforced by collaborative and socially cohesive practices. Overall, the results demonstrated a strong relationship between green innovation adoption and social networks, participation, trust, reciprocity, civic engagement, cohesion, and knowledge sharing.
Keywords: Social networks, Social capital, Green innovation, Textile industry, Sustainability, Eco-friendly environment.

Introduction
As a developing country, Pakistan faces numerous challenges in achieving sustainable economic growth while preserving its natural resources. Environmental degradation, including air pollution, deforestation, and water scarcity, has become a pressing concern that necessitates a holistic approach to address these issues. Growing occurrence of environmental problems in recent years meant that the sustainability and other-related ideas such as green innovation acquired special significance (Jilani et al., 2022). Environmental effects of human activities have become growing

global concern. The emissions of carbon dioxide from fossil fuels have reached record to area of high pressure. The global average sea levels rose to 20 cm from 1900 to 2018 and heat waves, forest fires and air pollution increased. Moreover, concentration of major greenhouse gases continued to increase in the last few years and global surface temperature for the period 2017–2021 is among the warmest ever recorded. Frequency and intensity of extreme weather and climate events have increased in all regions of the world leading to a growing need for governments to implement measures to reduce such environmental damage. The solution of these environmental problems is not just matter of governmental policy. The organizations also play a vital role in reducing these issues. The organizations must respond affectively to a double trending the current business market and should achieve efficiency and market share through constant innovation which requires resources, capabilities and investments. The organizations should also achieve certain degree of ethical responsibility and coherence with society in which they are operated upon. So, businesses today must find balance between competitive adjustment, innovation and legitimacy adjustment, sustainability and respect for the environment (Guinot et al., 2022).

Industries are changing rapidly due to green innovation as companies look to tackle environmental issues and take advantage of new economic prospects. A crucial but frequently disregarded factor driving this change is the social capital. The term social capital refers to networks, connections and reliance that enable collaboration and group action among people and organizations. In the context of green innovation, social capital serves as an important substance for the uptake and dissemination of sustainable behavior and technology. Businesses are increasingly realizing that green innovation requires an ecosystem that is friendly and cooperative, in addition to technological breakthroughs. This ecosystem is supported by social capital, which facilitates information exchange, promotes cooperative problem-solving, and increases stakeholder trust. Through robust networks and relationships, companies can access diverse resources, share best practices, and drive collective efforts towards sustainability. Social capital strengthens the framework within which green innovation thrives. By leveraging relationships and networks, industries can enhance their ability to develop and implement eco-friendly solutions, ultimately leading to more sustainable practices and a greener future for the industry. This introduction explores how social capital serves as a foundational element in fostering green innovation across various sectors, emphasizing its role in driving industry-wide transformation towards sustainability (Chaudhary, 2023).

The two primary categories of innovation identified in the literature are radical and gradual. The process of adding value to a current product or process by implementing new enhancements is known as incremental innovation. The hallmarks of incremental innovation are making little adjustments to a process, product, or service while producing outcomes quickly. When the market needs particular features of a current product or other production requirements, this innovation occurs. This kind of innovation is a frequent strategic approach in business that helps companies stay in business and make more money. On the other hand, the term "radical" or "disruptive" innovation describes the development of a novel product or service that has not yet been commercialized. High financial outlays, commitment, effort, research, and development are all necessary for this kind of invention. As a result, businesses frequently choose for incremental innovation rather than radical innovation. The fundamental conceptual distinctions between these two forms of invention are enumerated in Table 1 (Bouncken, 2018).

Being the most important growth driver, innovation advances a company to excellence and ensures a competitive edge. It also improves environmental efficiency, which contributes to the development of the social capital required for the future. A growing number of businesses have made green innovation (GI) a central part of their plan to counteract the drawbacks of conventional growth methods. State-level financial institutions have lately been established in a number of countries, such as Canada and Japan, to support Sustainable Development (SD) and adhere to the "Green Industry Plan." These organizations can use public-private partnerships (PPPs) to support technical innovation and green infrastructure. Additionally, by reducing resource consumption and waste in order to achieve SD, GI helps businesses to produce environmentally friendly goods. Following the identification of GI's primary advantages, a number of parties pushed for its adoption and use. Organizations must play a part in SD even though drastic change is required at the ecological, cultural, and social levels. However, a number of decision-making variables make it difficult for manufacturing firms to implement green innovation (GIA) and achieve SD (Ullah et al., 2021).

Network embeddedness can be divided into two categories: relational and structural. The location or arrangement of impersonal or inter-firm links inside a network determines structural embeddedness. Relationships and connections between social actors or groups that are impersonal or interfirm are reflected in structural embeddedness. The density, connectedness, and cohesiveness of network linkages among agents are some of the structural embeddedness factors that influence bonding social capital. Because businesses are a part of a network's social ties, structural embeddedness affects managers' decision-making and, consequently, the competitive behavior of businesses. The relational features of impersonal or inter-firm interactions within a network are reflected in relational embeddedness. A component of an individual's or organization's stock of social capital is relational embeddedness, which is built over time. The bridging social capital would be impacted by the traits of relational embeddedness, which are defined in terms of friendship, values, respect, trust, and norms. Nonetheless, a number of scholars have mentioned the connection between detrimental impacts and increased social capital embeddedness. This study makes the case that a firm's network embeddedness has a beneficial impact on its green social capital based on the traits of relational and structural embeddedness. In light of this, the following theory is put out (Chen et al., 2019).

First, the development of new goods or services or the enhancement of already-existing goods and services is referred to as product innovation. According to the Oslo Manual, product innovation happens when significant design modifications are made that enhance the unique characteristics of the function or application for which the product was developed. Product innovation is the process of applying technology or expertise to enhance components and materials. On the other hand, some product modifications might also be regarded as marketing innovations (Wang et al., 2021).

The green innovation (GI) is quite vital for conserving environmental management in the communities and organizations and studies in this area have primarily shown a growing tendency in recent years. Environmental deterioration poses a serious threat to human survival. Numerous groups and localities have promoted GI to achieve economic expansion and environmental preservation. Economic profitability and environmental sustainability are also important because GI can help businesses gain long-term competitive advantage. GI has become a crucial instrument

for companies seeking to increase their market share and sustain themselves over time. A prosperous green initiative (GI) enhances market standing, attracts clients, offers eco-friendly services and acquires a competitive edge (Imran et al., 2021).

GI has emerged as one of the most crucial strategic instruments for efficient and long-term growth. It used to be unnecessary to invest in environmental initiatives, but stringent environmental laws and growing environmental consciousness have altered the practical rules of competition. As a result, techniques and procedures related to environmental sustainability, including GI, have grown in popularity. Furthermore, many businesses have used the green agenda as a means of attaining a GI-based business model, as consumer awareness of sustainability has been increasing in recent years. GI practices are therefore a reasonable reaction to the demands of consumers who are prepared to pay more for sustainable goods and who anticipate businesses to provide them with more ethical goods and services. As GI practices boost product value and generate competitive advantages through ecological differentiation, prior research suggests that GI activities help a company's performance and competitiveness (Brosatto and Bazani, 2021).

Green innovation pioneers could be able to maintain their competitive advantages. By promoting the efficient use of raw materials, a green innovation strategy lowers material and waste disposal costs. Businesses may discover new methods to turn garbage into marketable goods that generate more income as a result of green innovation. Thus, effective green innovation aids businesses in strengthening their core capabilities and increasing efficiency, both of which may ultimately enhance their financial performance. Businesses must find ways to operate more sustainably without sacrificing profitability in order to improve their green performance. Green innovation gives businesses the chance to create environmentally friendly enhancements that are different from conventional resources. By guaranteeing that a more effective use of materials and energy lowers environmental impacts, green innovation can enhance a company's green performance. Green innovation is a creative approach to environmental management that can boost a company's capacity to create environmentally friendly goods and new processes. This in turn enhances a company's green performance and, thus, its green image. Accordingly, companies that contribute to excellent green performance view green innovation as a desirable asset (Zhang et al., 2020).

Objectives

- To explore how social networksaffect the adoption & spread of green innovation in industrial & organizational sectors.
- To investigate how different types of social capital support knowledge sharing, collaboration and eco-innovation.
- To evaluate the strategic role of social networks in promoting collective responsibility, policy support and long-term sustainability.

Review Of Literature

Green innovation is often seen as the primary route to sustainable development, according to research by Lou et al. (2023). Businesses' competitive edge is positively impacted, as evidenced by their social, economic, and environmental performance (Qiu et al., 2020). Businesses are creating "green innovation" to actively contribute to reducing pollution in the environment, increasing the effectiveness of resource use, and improving environmental performance. Economic performance is improved by green innovation because it raises the perceived value of such

products among consumers, which directly boosts business profits from the sale of green innovative products and offsets the costs associated with them (Huizhang et al., 2021). Furthermore, green innovation improves an organization's reputation or social image, which raises its social performance rate and gives it a competitive edge in the marketplace. (Ali et al, 2023). With the help of cutting-edge technology, the oil industry is constantly adapting to the future. It also strives to lessen its adverse effects on the environment and society in order to mitigate the threat of climate change and promote sustainable development. Additionally, the notion that businesses with greater endowments of resources and capabilities do better in green innovation. Lastly, Ding et al. (2022) effectively illustrate that green innovation is the process of moving from information sharing and absorption to internal capacities. In view of its advantages, the drivers of green innovation should be studied from different dimensions, which are a popular research topic (Li et al., 2017).

Wakeford and Gebreeyesus (2017) explained that the capability: It is generally argued that the dynamic capabilities, coordination capabilities and social reciprocity of a firm are important driving forces for GI, further confirmed that innovation capabilities have a larger influence on green innovation. Second, from an institutional theory perspective, foreign institutional pressures are the main drivers of GI and stakeholder legal pressures and environmental regulations drive green innovation. (Stucki et al 2018) argue that policies with the calling to be enforced, such as taxes and regulations, can inhibit entrepreneurship green innovation, while policies with the calling of incentives, such as subsidies and voluntary agreements, can encourage green product innovation. Third, from the perspective of social relationship networks, green innovation is dominated by focal and non-focal entities Fliaster and Kolloch (2017). Theorized that the interaction between companies and other network actors drives green innovation. The more active an enterprise is in its social relationship network and the more adhesion opportunities its members have with the network, the more likely the enterprise are to be involved in green innovation activities and subsequently achieve performance benefits. Fabrizi et al., 2018) argue that research networks, namely universities and public research centers, positively influence green innovation. Social capital, as the main carrier of green knowledge integration and exchange, has a positive impact on green innovation.

Methodology

This research employed a quantitative approach and was carried out in Punjab Province using a stratified random sampling technique to reflect the diversity of industrial clusters and job roles across four districts Lahore, Sialkot, Gujranwala, and Faisalabad with 109 respondents from each district, totaling 436 participants. Respondents were selected from industrial firms and included owners, managers, engineers, production supervisors, and sustainability managers, representing sectors such as textiles, sports goods, surgical instruments, and leather products, with one qualified individual chosen per firm to represent top management, technical staff, or sustainability specialists. Data were collected through a structured questionnaire designed according to the study's objectives and analyzed using SPSS. The analysis revealed that social capital plays a vital role in fostering green innovation, as social networks facilitate knowledge exchange, cooperation, and the adoption of sustainable practices, with a large majority of respondents (78–97%) affirming their contribution to awareness, learning, and environmentally friendly approaches. Factors such as participation, trust, reciprocity, civic involvement, cohesion, and collective action were also found to be important drivers of collaboration and green practices (80% agreement). The whole

methodological framework ensured that the research was empirically rigorous, ethically conducted, statistically reliable and contextually relevant providing robust insights into the effects of social capital on industrial innovation in Punjab.

Results & Discussions

Table: Socio-Economic Characteristics of the Participants

Variable	Category	Frequency	Percentage
Age (Years)	25-30	149	34.2
	31-35	116	26.6
	36-40	134	30.7
	41-40	36	8.3
	45-Above	1	0.2
Level of Education	Matriculation	25	5.7
	Intermediate	95	21.8
	Bachelor	259	59.4
	Masters	48	11.0
	PhD	9	2.1
Occupation	CEO/Managing Director	60	50.0
	Manager/Assistant Manager	24	20.0
	Technical Staff	4	3.3
	Others	32	7.0
Total Household Income	Less than 40,000	203	46.6
	41,000-60,000	87	20.0
	61,000-80,000	77	17.7
	81,001-100,000	32	7.3
	100,001 and above	37	8.5
Gender	Male	327	75.0
	Female	106	24.3
	Transgender	3	0.7
Marital Status	Single	125	28.7
	Married	279	64.0
	Divorced	22	5.0
	Separated	6	1.4
	Widow	4	0.9
Residential Area	Rural	173	39.7
	Urban	263	60.3
Type of Organization	Large Scale Industry	207	47.5
	Small Scale Industry	115	26.4
	Medium Scale Industry	99	22.7
	Public Sector Organization	15	3.4
Industry Experience	Less than 5 years	110	25.2
	5-10 years	142	32.6
	11-15 years	149	34.2
	16-20 years	16	3.7
	More than 20 years	19	4.4
Organization Size	Less than 100	164	37.6

	100-500	77	17.7
	500-1000	85	19.5
	More than 1000	107	24.5
Sector of Industry	Textile	109	25
	Leather	109	25
	Metal	109	25
	Sports	109	25
Organization Age (Years)	5-10	103	23.6
	10-15	158	36.2
	15-20	78	17.9
	20-25	96	22.0
Number of Employees	Less than 500	213	48.9
	500-1000	62	14.2
	1000-1500	40	9.2
	1500 & more	121	27.8

The demographic analysis shows that most respondents were young to middle-aged adults, particularly those between 25–40 years, with very few older participants, indicating a predominance of individuals more open to experimentation and technological change. Education levels were mainly at the bachelor's degree level, followed by intermediate qualifications, suggesting the perspectives of moderately educated professionals more engaged with contemporary issues and innovation adoption. Half of the respondents held leadership positions such as CEOs and managing directors, with fewer managers and technical staff, highlighting a strong focus on decision-making and strategic perspectives rather than operational experiences. Income distribution leaned toward lower- and middle-income groups, pointing to potential resource constraints that could affect innovation adoption, while gender representation was male-dominated, reflecting broader social disparities in participation. Most participants were married, urban residents, which may influence adoption patterns due to differing responsibilities and access to resources. Organizationally, the sample included a mix of large, medium, and small enterprises, with most respondents from private-sector industries, particularly textiles, leather, metal, and sports goods, ensuring balanced sectoral representation. Firms were generally mid-aged and varied in size, capturing perspectives from both resource-rich and resource-limited contexts. Respondents were largely mid-career professionals with substantial industry experience, further emphasizing adaptability and responsiveness to innovation. Family size also influenced adoption behaviors, with smaller families showing greater flexibility compared to larger households. Overall, the findings suggest that the sample reflects the views of younger, moderately educated, male, urban professionals from private-sector organizations, whose socio-economic and organizational contexts strongly shape their openness, adaptability, and approaches to adopting innovations.

Hypothesis 1: Social networks and its impact on unleashing green innovation in industrial sector.

Table 1: Association between adoption of Green Innovation and Social Network

Adoption of GI	Social Network			Total
	Low	Medium	High	
Low	90	70	20	180
	21%	16%	5%	41%
Medium	30	30	40	100
	7%	7%	9%	23%
High	20	26	110	156
	5%	6%	25%	36%
Total	140	126	170	436
	32%	29%	39%	100%

Chi= 152.86, P<0.00 **Highly Significant

The findings reveal a strong and significant link between social networks and the adoption of green innovation. Individuals who are more actively engaged in social networks adopt green practices at higher rates, as interactions, information exchange, and collaboration within these networks provide greater awareness, resources, and opportunities for implementing sustainable initiatives. Conversely, respondents with weaker social ties show lower adoption levels, emphasizing the importance of connectivity in driving environmental innovation. Statistical results ($\chi^2 = 152.86$, $p < 0.001$) confirm this association: among those with low adoption of green innovation, most fell into the low (21%) and medium (16%) social network categories, with only 5% in the high category, while those with high adoption were largely concentrated in the high social network group (25%), with just 5–6% in the low or medium levels. Medium adopters were more evenly distributed, indicating a clear trend that greater network involvement corresponds with stronger adoption of green practices. These outcomes align with Rogers' Diffusion of Innovation theory and Social Capital theory, reinforcing that social networks accelerate innovation adoption by facilitating information flow, strengthening perceived benefits, and leveraging peer influence, as also evidenced in prior studies on network effects in technology adoption

Conclusion

This quantitative research was carried out in Punjab Province using a stratified random sampling method to account for industrial diversity across four districts Lahore, Sialkot, Gujranwala, and Faisalabad. From each district, 109 respondents were selected, making a total of 436 participants.

The sample included professionals and representatives from industrial units such as owners, managers, engineers, production supervisors, and sustainability officers, covering key sectors like textiles, sports goods, surgical instruments, and leather products. The findings of the studyreflect that large-scale industries adopt green practices more readily yet the social networks provide smaller organizations with pathways to overcome resource constraints. The evidence highlights that trust, reciprocity and collaboration within networks are central to sustainability transitions helping industries balance competitiveness with environmental responsibility. Social capital is not only a driver of the organizational innovation but a strategic tool for broader sustainability goals as well. Consolidation of these networks across industries and communities can accelerate the progress of Pakistan toward eco-friendly industrial growth and sustainable development.

Recommendations

- Strengthen social networks and professional platforms to enhance knowledge sharing, collaboration, and diffusion of green innovation across industries.
- Promote active participation in industrial forums, civic platforms, and community-based initiatives to foster collective responsibility for sustainability.
- Build trust, reciprocity, and cohesion through transparent communication, cooperative ventures, and long-term partnerships among industries, communities, and government.
- Encourage collective action and knowledge sharing via training centers, workshops, online platforms, and industry–academia collaborations.
- Support green innovation through policy interventions, including subsidies, tax incentives, environmental support centers, and enforceable regulatory frameworks.

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