Annual Methodological Archive Research Review
http://amresearchreview.com/index.php/Journal/about
Volume 4, Issue 1 (2026)

Online ISSN 3007-3197
Print ISSN 3007-3189

http://amresearchreview.com/index.php/Journal/a

Value-Chain Configuration and Innovation Dynamics in Traditional Bioeconomy Sectors: Evidence from the Sugar Industry

Ramia Kiran
Lahore School of Accountancy and Finance, University of Lahore.
Atif Khan Jadoon
School of Economics, University of the Punjab, Pakistan.
Amjad Ali
Lahore School of Accountancy and Finance, University of Lahore.

ABSTRACT

This study investigates the influence of value-chain configuration on innovation dynamics within traditional bioeconomy sectors, with specific evidence drawn from the sugar industry in Pakistan. A quantitative research design was employed using questionnaire data collected from 197 respondents, including producers, processors, managers, technical experts, and knowledge intermediaries operating across the Pakistani sugar-industry value chain. The analysis was conducted using Jamovi and SPSS software through descriptive statistics, exploratory factor analysis, reliability analysis, correlation analysis, regression analysis, mediation analysis, and moderation analysis. The findings reveal that value-chain configuration exerts a significant positive influence on innovation dynamics by strengthening coordination mechanisms, facilitating knowledge-sharing practices, and enhancing organisational learning capabilities. The study further demonstrates that absorptive capacity and collaboration-oriented knowledge requirements partially mediate the relationship between value-chain configuration and innovation dynamics. The results indicate that innovation within traditional bioeconomy sectors remains predominantly incremental, efficiency-oriented, and interaction-driven rather than strongly technology-driven. In addition, competition and cost pressures were found to negatively moderate the relationship between value-chain configuration and innovation dynamics, explaining that excessive market pressure can weaken the innovation benefits associated with coordinated governance structures. These findings highlight the importance of collaborative governance frameworks, institutional support mechanisms, and inter-organisational learning processes in

Online ISSN 3007-3197
Print ISSN 3007-3189

promoting sustainability-oriented innovation within traditional bioeconomy industries in Pakistan. The study offers valuable implications for policymakers and industry stakeholders seeking to strengthen innovation performance through improved coordination, knowledge integration, and strategic value-chain governance.

Keywords: Value-Chain Configuration, Innovation Dynamics, Bioeconomy, Absorptive Capacity

Introduction

Growing concerns regarding climate change, environmental degradation, food insecurity, and resource depletion have positioned the transition toward a sustainable bioeconomy as a critical global priority (Gawel et al., 2019; Ogwu et al., 2025). Governments, international organisations, and industrial stakeholders are increasingly emphasising the restructuring of production systems to achieve environmental sustainability while ensuring long-term economic stability and social welfare (Rees, 2021). Traditional production models, which have historically depended heavily on fossil fuel consumption and inefficient resource utilisation, are now widely regarded as unsustainable in the context of rising global demand for food, energy, and industrial raw materials (Cherwoo et al., 2023). Consequently, the bioeconomy has emerged as a strategic framework that integrates biological resources, technological advancement, sustainable industrial practices, and circular production systems to support sustainable development objectives across multiple sectors. Within this transformation, traditional bioeconomy industries are expected not only to improve productivity and competitiveness but also to minimise environmental degradation, enhance resource efficiency, and strengthen climate resilience. Traditional bioeconomy sectors, particularly agriculture-based and biomass-processing industries, are increasingly confronted with pressures to improve productivity, reduce environmental impacts, and strengthen sustainability performance while maintaining economic competitiveness (Wang et al., 2022; Ullah et al., 2025; Ajayi & Akinbobola, 2025). These industries often operate under conditions characterised by volatile commodity prices, resource constraints, fragmented supply chains, changing consumer preferences, and expanding regulatory scrutiny concerning environmental performance. In many developing economies, traditional industries additionally face challenges associated with

Online ISSN 3007-3197
Print ISSN 3007-3189

inadequate technological infrastructure, weak institutional coordination, limited research and development investment, and low levels of digital transformation (Ateeq, 2024; Mhlanga, 2024). As a result, firms operating within these sectors are progressively expected to adopt innovative operational approaches capable of improving efficiency, reducing waste generation, enhancing product quality, and promoting sustainable resource management (Ezekwu, 2025). The growing emphasis on sustainability has therefore shifted industrial priorities toward innovation-driven development models that reconcile economic performance with environmental and social objectives.

Under such conditions, innovation becomes an essential mechanism for improving operational efficiency, optimising resource utilisation, and supporting long-term industrial sustainability. Importantly, innovation within traditional industries does not necessarily depend on radical technological breakthroughs or substantial research and development expenditures (Leifer, 2000; Khalid et al., 2025). Rather, innovation in these sectors frequently emerges through incremental improvements, process adaptations, collaborative problem-solving, knowledge-sharing practices, and organisational learning mechanisms that collectively enhance overall industrial performance. Improvements in supply-chain coordination, waste recycling systems, energy-efficiency initiatives, sustainable farming practices, digital monitoring technologies, and collaborative governance structures represent examples of innovations that contribute simultaneously to industrial modernisation and sustainability advancement (Allam & Cheshmehzangi, 2024; Ezekwu, 2025; Rana et al., 2025). Although innovation research has historically focused on high-technology and research-intensive industries, recent scholarship increasingly recognises that traditional and low-technology sectors also generate significant forms of innovation through organisational learning, coordination systems, incremental process improvements, and collaborative knowledge exchange. Earlier innovation literature predominantly associated innovative capacity with technologically advanced industries such as information technology, biotechnology, electronics, and pharmaceuticals, where formal research laboratories and scientific development activities play a central role (McMillan et al., 2000). Contemporary perspectives, however, acknowledge that innovation processes within traditional industries

Online ISSN 3007-3197
Print ISSN 3007-3189
http://amresearchreview.com/index.php/Journal/a

frequently evolve through practical experimentation, operational adaptation, inter-organisational collaboration, and cumulative learning experiences embedded within routine production activities. Such forms of innovation are particularly important in agriculture-based and resource-dependent sectors, where productivity, sustainability performance, and competitiveness depend heavily on effective coordination among multiple actors operating across interconnected value-chain systems.

Among traditional bioeconomy industries, the sugar sector provides an especially relevant context for examining innovation dynamics because it combines agricultural production, industrial processing, logistics coordination, sustainability requirements, and interdependent stakeholder relationships within a complex value-chain structure (Bauer et al., 2018; Celik et al., 2025). The sugar industry holds substantial strategic importance in many economies due to its contribution to employment generation, rural livelihoods, industrial development, export earnings, and food supply systems (Solomon, 2016). Simultaneously, the sector faces growing pressure to improve environmental sustainability because sugar production is associated with intensive water consumption, land-use challenges, high energy demand, waste generation, and greenhouse gas emissions. In response to these challenges, industry participants are increasingly exploring innovative production methods, waste-to-energy technologies, circular economy strategies, and environmentally sustainable agricultural practices to improve both economic and environmental performance. Consequently, the sugar industry offers an appropriate empirical setting for understanding how innovation evolves within traditional bioeconomy sectors characterised by strong operational interdependencies and sustainability-oriented transformation pressures (Dürr et al., 2024; Zartha Sossa et al., 2025). Unlike high-technology industries, where innovation is often driven primarily by formal research and development activities, innovation in traditional biomass-processing sectors frequently emerges through interaction-based learning, operational adaptation, and coordination among producers, processors, technical specialists, and supporting institutions.

Informal learning systems, practical problem-solving experiences, and stakeholder collaboration frequently play more significant roles in generating operational improvements and sustainability-oriented innovations than formal scientific research

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Print ISSN 3007-3189

alone (do Prado et al., 2025). This interaction-oriented innovation process highlights the importance of social relationships, institutional coordination, and governance mechanisms in shaping industrial transformation within traditional bioeconomy systems. Accordingly, value-chain governance mechanisms become critically important in determining the evolution of knowledge transfer, innovation capabilities, and sustainability-oriented practices across the sector. Effective governance structures facilitate coordination among value-chain actors, reduce information asymmetries, strengthen trust-based relationships, and encourage collaborative decision-making processes that support innovation development. Moreover, governance systems influence resource allocation, technology diffusion, production standards, environmental compliance, and market integration throughout the industry. In the sugar sector, where numerous stakeholders operate across interconnected agricultural and industrial stages, the degree of value-chain coordination directly affects the industry's ability to achieve productivity improvements, accomplish sustainability objectives, and maintain long-term competitiveness. Understanding the relationship between value-chain configuration and innovation dynamics is therefore essential for identifying pathways that can support sustainable transformation within traditional bioeconomy industries. Existing studies have examined open innovation, sustainability transitions, digital transformation, organisational learning, and innovation systems within agri-food industries (Venturelli et al., 2022; Piot-Lepetit, 2023; Krasnokutska et al., 2025; Ghauri et al., 2025; Manta, 2026). However, limited attention has been devoted to the structural role of value-chain configuration in shaping innovation behaviour within traditional bioeconomy sectors. In particular, prior research has not adequately explained how governance mechanisms, coordination processes, inter-organisational relationships, and organisational learning collectively influence innovation outcomes in mature low-technology industries such as the sugar sector. To address this gap, the present study develops an integrated analytical framework that examines how value-chain configuration influences innovation dynamics through the mediating roles of absorptive capacity, knowledge-coordination conditions, and collaborative innovation processes.

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1. Literature review

1.1. Value-Chain Governance and Innovation Dynamics

The analytical perspective of value-chain governance has significantly enhanced the understanding of coordination mechanisms, control structures, and knowledge-sharing processes within production systems (Boshkoska et al., 2019; Zhao et al., 2021; Liu et al., 2025). Governance frameworks determine how resources are allocated, how activities are coordinated among participating actors, and how decision-making authority shapes organisational behaviour across supply chains (Vurro et al., 2009). Existing literature identifies several governance forms, including hierarchical, modular, relational, captive, and market-based systems, each associated with distinct implications for coordination efficiency, learning opportunities, and innovation performance. Within agri-food and bioeconomy industries, governance structures are particularly important because innovation activities often depend on collaboration among producers, processors, suppliers, research institutions, and governmental agencies rather than solely on firm-level research and development initiatives (Poponi et al., 2021; Sgroi, 2022; Krasnokutska et al., 2025; Kanwal et al., 2025).

Research on global value chains demonstrates that governance mechanisms strongly influence coordination intensity, supplier dependence, and knowledge transfer among actors operating within production networks (Ponte et al., 2019; Audi et al., 2022; Qin & Sun, 2026). However, a substantial portion of this literature concentrates primarily on export-oriented industries and international commodity chains, while comparatively limited attention has been devoted to traditional low-technology bioeconomy sectors such as sugar processing (Egea et al., 2021; Piot-Lepetit, 2023; Krasnokutska et al., 2025). Relational governance arrangements may strengthen trust-based interactions, collaborative learning, and joint experimentation among value-chain participants (Grohmann et al., 2023; Rivera & Moreno, 2024; Prakash & Ali, 2026). Although these insights provide an important theoretical foundation, empirical evidence explaining how different governance configurations influence innovation processes remains limited within traditional biomass-processing industries. Consequently, a substantial theoretical and empirical gap persists concerning the relationship between governance structures and

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Print ISSN 3007-3189

innovation dynamics in traditional bioeconomy sectors.

1.2. Innovation in Traditional Bioeconomy Sectors

Innovation within traditional bioeconomy industries differs substantially from the innovation processes commonly observed in high-technology sectors. Conventional innovation literature has historically associated innovation with formal research and development activities, advanced technological investments, and the generation of scientific knowledge (Golembiewski et al., 2015; Marc & Ali, 2019; Wang et al., 2022; Stavar, 2025; Ullah et al., 2025). However, contemporary research on mature industries increasingly demonstrates that low-technology sectors are also capable of generating significant innovation through incremental process improvements, operational adaptation, experiential learning, and coordinated organisational practices (Bibi, 2019; Owusu & Novignon, 2021; Salleh & Sapengin, 2023; Ateeq, 2024; Mhlanga, 2024).

Traditional bioeconomy sectors, including agriculture, food processing, forestry, and sugar production, often depend more heavily on practical experimentation, efficiency enhancement, logistics optimisation, and improved resource utilisation than on radical technological breakthroughs. In these industries, innovation is not confined solely to formal research laboratories but is frequently embedded within day-to-day production activities and inter-organisational collaboration processes (Bauer et al., 2018; Akim, 2020; Can, 2021; Celik et al., 2025; Krasnokutska et al., 2025; Yeung & Chung, 2025; Manta, 2026). As a result, innovation performance in such sectors largely depends upon coordination mechanisms, knowledge-sharing practices, and learning interactions among stakeholders operating throughout the value chain. The literature on sustainability-oriented innovation further highlights that innovation within bioeconomy industries is increasingly shaped by environmental pressures, resource-efficiency requirements, and circular economy objectives. Firms operating in traditional sectors face growing pressure to adopt environmentally sustainable production methods, minimise waste generation, improve energy efficiency, and strengthen resource recovery systems (Simboli et al., 2014; Ali et al., 2019; Tila & Cera, 2021; van Zanden, 2023; Iqbal & Noman, 2025). Although sustainability-oriented innovation has attracted considerable scholarly attention, prior studies have primarily concentrated on technological adoption and environmental management

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Print ISSN 3007-3189
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strategies, while paying comparatively limited attention to the ways governance structures and supply-chain collaboration influence sustainability-driven innovation processes within traditional industrial settings.

1.3. Knowledge Coordination and Absorptive Capacity

Knowledge coordination plays a central role in innovation processes because innovation frequently depends on the ability of firms to exchange, integrate, and utilise information obtained from both internal and external sources (Trantopoulos et al., 2017; Wang et al., 2018; Karhan, 2019; Aliasghar et al., 2023; Iqbal & Hayat, 2025). Within traditional bioeconomy industries, producers, processors, technical experts, suppliers, and intermediary organisations commonly engage in collaborative knowledge-sharing activities to improve operational performance and address production challenges. Effective coordination mechanisms enhance the speed and quality of communication, reduce information fragmentation, and facilitate collective problem-solving, thereby strengthening innovation performance throughout the value chain (Bodas Freitas & Fontana, 2018; Baah et al., 2022; Geda, 2023; Iqbal & Noman, 2025).

The concept of absorptive capacity provides additional insight into how organisations recognise, assimilate, and apply external knowledge for innovative purposes (Horvat et al., 2019; Ahmed & Hu, 2025). Firms possessing higher absorptive capacity are generally more capable of identifying valuable information, integrating external expertise, and transforming acquired knowledge into successful innovation outcomes (Flor et al., 2018; Jamel & Zhang, 2024; Kumar & Wu, 2025). The absorptive capacity significantly influences innovation adoption, organisational learning, and technological adaptation, particularly in industries where innovation depends more heavily on collaboration and knowledge exchange than on formal research intensity (William, 2021; Wang & Zhou, 2023; Kumar & Gupta, 2023; Ito & Zhang, 2025). Although absorptive capacity has been widely examined within manufacturing and high-technology sectors, comparatively limited empirical attention has been devoted to its role within traditional bioeconomy industries. Existing studies frequently conceptualise absorptive capacity primarily as an internal organisational capability, while giving insufficient consideration to the structural influence of value-chain governance on learning opportunities and

Online ISSN 3007-3197
Print ISSN 3007-3189

knowledge accessibility (Prajogo et al., 2008; Hernández-Espallardo et al., 2010; Kano, 2018; Zhang & Wu, 2020; Denial, 2023). This represents an important theoretical limitation because governance structures may directly shape the efficiency of actor interaction, coordination processes, and innovation-related knowledge acquisition across the value chain.

1.4. Innovation Modes and Open Innovation Perspectives

The distinction between Science-Technology-Innovation and Doing-Using-Interacting innovation modes provides an important conceptual framework for understanding innovation behaviour within traditional industries (Alhusen et al., 2019; Hädrich et al., 2025). Science-Technology-Innovation innovation is generally associated with formal scientific research, codified knowledge, and technology-driven development processes. In contrast, the Doing-Using-Interacting approach emphasises experiential learning, operational experimentation, interaction-based knowledge exchange, and problem-solving through practical engagement among industry participants (Dooley et al., 2022; Najda-Janoszka et al., 2025).

Traditional bioeconomy industries are more commonly characterised by Doing-Using-Interacting innovation processes because innovation activities frequently emerge through operational experience, collaborative learning, and adaptive practices embedded within production environments (Allam & Cheshmehzangi, 2024; Ezekwu, 2025). Nevertheless, formal scientific knowledge continues to play an important role through technical research institutions, agricultural extension services, and specialised technical support systems. Consequently, innovation within the sugar industry and related bioeconomy sectors may best be understood as a hybrid process that combines formal scientific inputs with interaction-based learning mechanisms (Poponi et al., 2021; Sgroi, 2022; Dürr et al., 2024; Zartha Sossa et al., 2025). This perspective is further reinforced by Open Innovation Theory, which emphasises that innovation increasingly depends upon external collaboration, distributed knowledge networks, and inter-organisational learning rather than solely on internally closed development systems. Within traditional bioeconomy industries, innovation commonly arises through cooperation among firms, farmers, technical specialists, universities, intermediary institutions, and other stakeholders

Online ISSN 3007-3197
Print ISSN 3007-3189
http://amresearchreview.com/index.php/Journal/a

operating within broader production networks. In this context, knowledge brokers and coordinating organisations perform a critical role in facilitating innovation diffusion and collaborative learning processes across the value chain.

2. Theoretical Framework

Traditional bioeconomy sectors operate through interconnected production networks in which innovation depends not only on internal organisational capabilities but also on coordination mechanisms, governance structures, and inter-organisational learning processes across the value chain. The primary theoretical foundation of this study is based on Value-Chain Governance Theory, which explains how coordination arrangements, power relations, and governance systems shape organisational behaviour within interconnected production systems (Hess, 2008; McWilliam et al., 2020). According to this perspective, governance arrangements influence the distribution of authority, coordination intensity, information flows, and dependency relationships among actors operating throughout a value chain. Governance structures are commonly categorised into market-based, modular, relational, captive, and hierarchical forms depending on transaction complexity, information codifiability, and supplier capabilities (Song et al., 2013; Kano, 2018). Governance systems are particularly significant within traditional bioeconomy sectors because production activities involve multiple interconnected stakeholders, including producers, processors, distributors, technical specialists, and supporting institutions (Iriarte et al., 2021). The sugar industry represents a highly coordinated industrial system in which interactions among participants substantially influence operational performance, learning opportunities, and innovation adoption (Gerwel Proches & Bodhanya, 2015; Gallego-Bono et al., 2022). Relational governance structures may strengthen trust, collaboration, and interaction-based learning, whereas more centralised governance frameworks can enhance strategic coordination, operational consistency, and resource alignment (Pilbeam et al., 2012; Siklar et al., 2026).

Innovation processes within traditional bioeconomy sectors differ considerably from those commonly observed in high-technology industries. Conventional innovation theories generally associate innovation with formal research and development

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Volume 4, Issue 1 (2026)

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activities, scientific advancement, and technological breakthroughs. In mature low-technology industries, however, innovation is more frequently generated through incremental improvements, operational adaptation, organisational learning, process optimisation, and practical experimentation rather than through radical technological transformation. Traditional bioeconomy sectors such as sugar manufacturing operate in environments where innovation is embedded within routine production activities, resource-management strategies, logistics systems, and efficiency-enhancing practices. Consequently, innovation is better understood as a distributed process involving multiple stakeholders across the value chain rather than as a centralised activity confined solely to formal research departments. This perspective is important because it recognises that innovation in traditional industries is largely interaction-driven, experience-based, and highly dependent upon coordination mechanisms and inter-organisational relationships.

Based on theoretical discussion, the functional form of the model can be written as:

$$ID_i=f(VC_i,KC_i,AC_i,IM_i,CCP_i,SRP,GP_i) \quad (1)$$

Where ID is innovation dynamics, VC value-chain set up, KC knowledge and coordination conditions, AC absorptive capacity, IM innovation mode, CCP competition and cost pressure, SRP sustainability and regulatory pressure, and GP geographical proximity.

The linear econometric specification of the main model is:

$$ID_i=\beta_0+\beta_1 VC_i+\beta_2 KC_i+\beta_3 AC_i+\beta_4 IM_i+\beta_5 CCP_i+\beta_6 SRP_i+\beta_7 GP_i+\varepsilon_i \quad (2)$$

The integrated empirical model combining direct, mediating, and moderating effects may be expressed as:

$$ID_i=\beta_0+\beta_1 VC_i+\beta_2 KC_i+\beta_3 AC_i+\beta_4 IM_i+\beta_5 CCP_i+\beta_6 SRP_i+\beta_7 GP_i+\beta_8(VC_i\times CCP_i)+\beta_9(VC_i\times SRP_i)+\beta_{10}(VC_i\times GP_i)+\varepsilon_i \quad (3)$$

This integrated specification comprehensively captures the direct effects of governance structures, the mediating effects of learning and coordination mechanisms, and the moderating influence of external environmental pressures within the sugar-industry value chain.

Table 1: Measurement and Definitions of the Variables

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Variable Abbreviation	Variable Name	Variable Type	Definition	Measurement Indicators
VC	Value-Chain Configuration	Independent Variable	Refers to the structural arrangement, governance mechanism, coordination intensity, and power relationships among actors operating within the bioeconomy value chain.	Governance structure, coordination mechanisms, centralisation, collaboration intensity, inter-organisational relationships
KC	Knowledge and Coordination Conditions	Mediating Variable	Refers to the effectiveness of communication, knowledge exchange, coordination practices, and collaborative interaction among value-chain participants.	Knowledge sharing, communication quality, coordination efficiency, collaborative interaction, and trust among actors
AC	Absorptive Capacity	Mediating Variable	Refers to the organisational capability to acquire, assimilate, interpret, and apply external knowledge for	Knowledge acquisition, learning capability, adaptation ability, and external knowledge

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Print ISSN 3007-3189
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Variable Abbreviation	Variable Name	Variable Type	Definition	Measurement Indicators
			innovation and operational improvement.	utilisation
IM	Innovation Mode	Mediating Variable	Refers to the dominant pattern of innovation activities adopted within the industry, including interaction-based learning and formal technological innovation processes.	Practical experimentation, interaction-based learning, technological adaptation, and formal innovation practices
ID	Innovation Dynamics	Dependent Variable	Refers to the extent and intensity of innovation activities occurring within the value chain, including innovation adoption, process improvement, and innovation diffusion.	Innovation adoption, process improvement, experimentation, innovation diffusion, operational innovation
CCP	Competition and Cost Pressure	Moderating Variable	Refers to external market competition and operational cost constraints influencing organisational	Competitive intensity, operational cost pressure, pricing pressure, and market uncertainty

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Print ISSN 3007-3189

Variable Abbreviation	Variable Name	Variable Type	Definition	Measurement Indicators
			innovation behaviour and strategic decisions.	
SRP	Sustainability and Regulatory Pressure	Moderating Variable	Refers to environmental regulations, sustainability standards, and institutional pressures influencing innovation and sustainability practices.	Environmental regulations, policy compliance, sustainability requirements, and regulatory expectations
GP	Geographical Proximity	Moderating Variable	Refers to the physical and regional closeness among actors within the value chain that facilitates communication, collaboration, and knowledge transfer.	Regional closeness, physical accessibility, local interaction, and proximity-based coordination

This study has used primary cross-sectional data, which were collected through a structured questionnaire survey using purposive sampling from 197 respondents operating across the Pakistani sugar-industry value chain, including producers, processors, managers, technical experts, and knowledge intermediaries. Purposive sampling was employed to select respondents with direct involvement and practical

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Print ISSN 3007-3189

experience in the Pakistani sugar-industry value chain. The questionnaire responses were gathered through direct field interaction and institutional distribution among value-chain participants, and the collected data were analysed using Jamovi and SPSS software through descriptive statistics, reliability analysis, exploratory factor analysis, regression analysis, mediation analysis, and moderation analysis.

3. Results and Discussion

This section provides estimated results and discussion. Table 2 provides descriptive statistics which explain that all variables recorded mean values above the midpoint of the measurement scale, indicating that respondents generally perceived moderate to relatively strong levels of governance coordination, learning processes, innovation activities, and sustainability-oriented practices across the sector. Innovation Mode reported the highest mean value, explaining that respondents strongly recognised the presence of operational adaptation, practical experimentation, and experience-based learning within the value chain. This finding implies that innovation within the sugar industry is primarily driven by interaction-based learning and incremental operational improvements rather than by advanced technological transformation. The relatively high mean value for Value-Chain Configuration further indicates that governance and coordination arrangements within the sector are comparatively well structured. This result reflects organised communication patterns and operational collaboration among producers, processors, technical experts, and intermediary actors operating throughout the industry. Knowledge and Coordination Conditions demonstrated moderate agreement among respondents, explaining that information-sharing practices and collaborative interaction are present within the value chain, although the degree of coordination efficiency may vary across firms and production stages. The moderate mean value associated with Absorptive Capacity indicates that firms within the sugar industry possess a reasonable ability to acquire, assimilate, and apply external knowledge for operational improvement and innovation purposes. However, Innovation Dynamics recorded comparatively lower mean values than several other variables, implying that innovation activities within the sector remain relatively modest and incremental in nature. Sustainability-Oriented Innovation also demonstrated moderate

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Print ISSN 3007-3189

agreement among respondents, reflecting an increasing awareness of environmental sustainability, waste reduction, and resource-efficiency practices within the industry. In addition, Competition and Cost Pressure, Sustainability and Regulatory Pressure, and Geographical Proximity all exhibited moderate mean values, highlighting the significant influence of external economic pressures, environmental expectations, and regional interaction within the value-chain environment. The standard deviation values remained within an acceptable range, indicating moderate variability in responses and explaining a reasonable degree of consistency in respondents' perceptions. Furthermore, the minimum and maximum values confirmed that participants utilised the full range of the measurement scale, thereby strengthening the representativeness and validity of the collected data.

Table 2: Descriptive statistics

Construct	Mean	Std. Dev.	Min	Max
Value-Chain Configuration (VC)	3.59	0.55	2.12	5.00
Knowledge & Coordination (KC)	3.40	0.48	2.00	5.00
Absorptive Capacity (AC)	3.48	0.51	2.00	5.00
Innovation Mode (IM)	3.70	0.53	2.20	5.00
Innovation Dynamics (ID)	3.26	0.44	2.00	4.89
Sustainability-Oriented Innovation (SI)	3.55	0.49	2.30	5.00
Competition & Cost Pressure (CCP)	3.48	0.53	2.20	5.00
Sustainability & Regulatory Pressure (SRP)	3.37	0.47	2.00	5.00
Geographical Proximity (GP)	3.60	0.52	2.30	5.00

Table 3 indicates that value-Chain Configuration exhibited particularly strong reliability, indicating that the items related to governance mechanisms, coordination frameworks, and inter-organisational relationships consistently measured the intended construct. This finding implies that respondents shared relatively similar perceptions regarding the structural organisation and governance arrangements operating within the sugar-industry value chain. Likewise, Knowledge and Coordination Conditions demonstrated satisfactory reliability, reflecting consistency

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in respondents' evaluations concerning communication practices, knowledge-sharing mechanisms, and collaborative interaction among value-chain participants. The reliability analysis further revealed that Absorptive Capacity maintained stable internal consistency, confirming that the measurement items effectively represented learning capabilities, external knowledge utilisation, and adaptive processes within the industry. Similarly, Innovation Mode demonstrated reliable measurement consistency, explaining that the indicators associated with practical learning, experimentation, and innovation practices appropriately captured innovation behaviour within traditional bioeconomy sectors. Innovation Dynamics and Sustainability-Oriented Innovation also achieved strong reliability levels, indicating that respondents consistently interpreted items related to innovation intensity, process improvement, environmental practices, and sustainability-oriented operational transformation.

Table 3: Reliability Analysis

Construct	Cronbach's α	McDonald's ω
Value-Chain Configuration (VC)	0.87	0.89
Knowledge & Coordination (KC)	0.83	0.85
Absorptive Capacity (AC)	0.81	0.83
Innovation Mode (IM)	0.79	0.81
Innovation Dynamics (ID)	0.85	0.87
Sustainability-Oriented Innovation (SI)	0.84	0.86
Competition & Cost Pressure (CCP)	0.78	0.80
Sustainability & Regulatory Pressure (SRP)	0.79	0.81
Geographical Proximity (GP)	0.82	0.83

Table 4 demonstrates that Value-Chain Configuration exhibited a strong positive relationship with Innovation Dynamics, indicating that more structured governance systems and coordinated value-chain arrangements are associated with stronger innovation activities within the industry. This finding supports the theoretical argument that governance structures play a critical role in facilitating

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communication, collaboration, and operational alignment among actors operating throughout the value chain. The result further explains that effective coordination systems create an environment that encourages innovation adoption, process improvement, and organisational learning. The analysis revealed a strong positive association between Knowledge and Coordination Conditions and Innovation Dynamics. This finding indicates that communication quality, collaborative interaction, and knowledge-sharing practices contribute substantially to innovation performance across the sugar-industry value chain. The result reinforces the theoretical perspective that innovation within traditional bioeconomy sectors relies heavily on interaction-based learning and coordination among interconnected actors rather than depending exclusively on formal research and development activities. Absorptive Capacity demonstrated a positive relationship with Innovation Dynamics, explaining that organisations possessing stronger capabilities to acquire, interpret, and apply external knowledge are more likely to engage in innovation-related activities. This finding highlights the importance of organisational learning and knowledge utilisation within mature low-technology industries, where innovation frequently emerges through operational adaptation and continuous improvement rather than through radical technological breakthroughs.

Innovation Mode also displayed positive associations with both Innovation Dynamics and Sustainability-Oriented Innovation. This result implies that practical experimentation, interaction-based learning, and collaborative innovation practices strengthen innovation performance while simultaneously supporting sustainability-related operational improvements within the industry. These findings reinforce the importance of interaction-driven innovation processes within traditional bioeconomy sectors such as sugar processing, where day-to-day learning and collaborative adaptation remain central to industrial development. Furthermore, the correlation analysis revealed positive relationships between Sustainability-Oriented Innovation and all major explanatory variables, indicating that governance coordination, knowledge exchange, organisational learning, and innovation activities collectively contribute to environmental sustainability and resource-efficiency practices across the value chain. These findings explain that sustainability-oriented innovation within traditional industries emerges through the combined influence of structural,

Online ISSN 3007-3197
Print ISSN 3007-3189
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organisational, and learning-related factors operating in a coordinated manner. Importantly, the correlation matrix did not reveal excessively high correlations among the constructs, indicating the absence of severe multicollinearity concerns and confirming that each variable captures a distinct conceptual dimension within the theoretical framework. Overall, the correlation analysis provides preliminary empirical support for the proposed research model by demonstrating that governance structures, coordination mechanisms, absorptive capacity, and innovation practices are significantly interconnected within the sugar-industry value chain.

Table 4: Correlation Analysis

Construct	VC	KC	AC	IM	ID	SI
Value-Chain Configuration (VC)	1.00	0.62**	0.60**	0.50**	0.68**	0.56**
Knowledge & Coordination (KC)	0.62**	1.00	0.68**	0.55**	0.64**	0.59**
Absorptive Capacity (AC)	0.60**	0.68**	1.00	0.52**	0.58**	0.55**
Innovation Mode (IM)	0.50**	0.55**	0.52**	1.00	0.61**	0.60**
Innovation Dynamics (ID)	0.68**	0.64**	0.58**	0.61**	1.00	0.62**
Sustainability-Oriented Innovation (SI)	0.56**	0.59**	0.55**	0.60**	0.62**	1.00

Table 5 indicates that the regression model was statistically significant and demonstrated satisfactory explanatory power in predicting Innovation Dynamics within the Pakistani sugar industry. The results support the central theoretical argument of the study that governance structures, organisational learning, coordination mechanisms, and innovation practices collectively influence innovation performance within the sugar industry. The regression outcomes further explain that innovation within traditional bioeconomy sectors in Pakistan is strongly associated with interaction-based learning, coordinated governance systems, and knowledge-sharing practices rather than relying exclusively on formal technological

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research activities (Allam & Cheshmehzangi, 2024; Ezekwu, 2025). Value-Chain Configuration emerged as the strongest predictor of Innovation Dynamics, indicating that structured governance arrangements, coordinated interaction, and organised value-chain systems significantly enhance innovation-related activities throughout the industry. This finding is consistent with the theoretical perspective that governance structures influence communication effectiveness, strategic alignment, and the quality of collaborative relationships among value-chain participants, thereby creating favourable conditions for innovation adoption and operational improvement (Ambos et al., 2021). The result further implies that stronger coordination mechanisms within the Pakistani sugar-industry value chain facilitate innovation diffusion and strengthen organisational adaptability. The regression analysis also demonstrated that Knowledge and Coordination Conditions exert a significant positive influence on Innovation Dynamics. This finding explains that effective communication systems, collaborative interaction, and knowledge-sharing practices play an important role in enabling innovation activities across the value chain. The results reinforce the theoretical position that innovation within traditional bioeconomy sectors depends heavily upon interaction-based learning and coordination among interconnected actors. Organisations operating within environments characterised by stronger coordination and information exchange appear to be better positioned to improve operational practices and sustain innovation-related activities (Wang & Hu, 2020; Shi et al., 2022).

Absorptive Capacity was found to positively affect Innovation Dynamics, indicating that organisations with stronger capabilities to acquire, assimilate, and apply external knowledge are more likely to demonstrate higher innovation performance. This finding emphasises the importance of organisational learning capabilities, particularly within mature low-technology industries where innovation frequently depends on adapting and utilising external expertise rather than generating internally driven scientific research alone (Flor et al., 2018; Ávila, 2022). The result supports that learning capability remains a critical requirement for strengthening innovation adoption and diffusion within the Pakistani sugar-industry value chain. Innovation Mode also contributed significantly to Innovation Dynamics, explaining that practical experimentation, interaction-based learning, and operational

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adaptation support innovation activity within the industry. This finding aligns with the theoretical distinction between Science-Technology-Innovation and Doing-Using-Interacting innovation modes, as traditional bioeconomy sectors tend to rely more heavily on experiential learning and collaborative operational refinement than on highly formalised technological development processes (Shang et al., 2026). The findings indicate that external economic pressures exert a comparatively weaker influence on Innovation Dynamics than governance coordination and organisational learning factors (Jiao et al., 2022; Song & Zhao, 2024). Although market competition and cost constraints remain relevant within the Pakistani sugar industry, structural coordination mechanisms and knowledge-related capabilities appear to be more decisive determinants of innovation performance within the value-chain environment. The demographic control variables included in the model did not exhibit a substantial influence on Innovation Dynamics, explaining that innovation-related perceptions and activities are explained more effectively by organisational and structural factors than by respondents' demographic characteristics (Quazi & Talukder, 2011). This outcome further strengthens the study's emphasis on governance systems, coordination mechanisms, and organisational learning capabilities as the principal determinants of innovation behaviour within traditional bioeconomy sectors in Pakistan.

Table 5: Regression Analysis

Innovation Dynamics (ID): Dependent Variable

Predictor	B	SE	t-value	p-value
Value-Chain Configuration (VC)	0.32	0.08	4.00	0.001
Knowledge & Coordination (KC)	0.15	0.07	2.14	0.033
Absorptive Capacity (AC)	0.18	0.08	2.25	0.026
Innovation Mode (IM)	0.22	0.09	2.44	0.015
Competition & Cost Pressure (CCP)	0.12	0.06	1.90	0.058
Gender (Male)	0.08	0.06	1.35	0.177
Age Group (25-34)	-0.10	0.07	-1.43	0.153

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The mediation results support the argument that governance structures shape innovation outcomes by improving the relational and coordination-oriented mechanisms operating throughout the value chain. More specifically, well-organised and strategically aligned value-chain configurations appear to create an environment in which information exchange, collaborative interaction, and collective learning processes function more effectively. As coordination quality improves, organisations operating within the Pakistani sugar-industry network become better positioned to exchange technical expertise, jointly address operational challenges, and implement improved production practices. Over time, stronger coordination mechanisms facilitate the diffusion and practical application of innovation activities across multiple stages of the value chain rather than limiting innovation to isolated organisational units. The mediation effect further highlights the importance of interaction-driven learning within traditional bioeconomy sectors. In mature low-technology industries, innovation frequently emerges through communication, operational collaboration, and experience-based learning rather than depending exclusively on formal scientific research and advanced technological development. From this perspective, governance structures contribute to innovation performance primarily by enabling the interaction processes through which actors acquire, share, and apply practical knowledge within production environments.

Table 6: Mediation Analysis

Indirect Effect	B	SE	t-value	p-value
VC → KC → ID	0.12	0.06	2.00	0.045

The moderation effect further explains that the existence of well-structured value-chain systems alone may not always guarantee stronger innovation outcomes, particularly when firms are confronted with severe financial constraints, rising operational costs, and highly competitive market environments. Under such conditions, many organisations may prioritise short-term survival strategies, cost reduction, and operational efficiency rather than investing in longer-term innovation activities. Consequently, the positive contribution of governance coordination to

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innovation performance becomes comparatively weaker within highly pressured economic environments. The findings additionally indicate that firms operating within relatively stable or moderately competitive environments are generally better positioned to utilise coordination systems, collaborative relationships, and governance mechanisms in ways that support innovation-related activities. When financial pressures are less severe, organisations are more likely to possess the flexibility required to invest in organisational learning, operational experimentation, sustainability improvements, and innovation adoption. In contrast, excessive market pressure may reduce firms' willingness to undertake innovation-related risks because organisations become increasingly resource-constrained and risk-averse under financially challenging conditions.

Table 7: Moderation Analysis

Moderator (CCP)	β	SE	t-value	p-value
Interaction (VC × CCP)	-0.13	0.06	-2.17	0.031

4. Conclusion

This study investigated the relationship between value-chain configuration and innovation dynamics within traditional bioeconomy sectors, with particular emphasis on the sugar industry in Pakistan. The empirical findings confirmed that value-chain configuration plays a significant role in strengthening innovation dynamics across the Pakistani sugar-industry value chain. Coordinated governance structures, effective communication systems, and inter-organisational interaction were found to positively support innovation-related activities, operational adaptation, and organisational learning. The results further demonstrated that Knowledge and Coordination Conditions significantly mediate the relationship between Value-Chain Configuration and Innovation Dynamics, indicating that governance structures influence innovation performance largely through improved communication, collaboration, and knowledge-sharing mechanisms among actors operating throughout the value chain. Furthermore, Innovation Mode emerged as an important determinant of innovation performance, confirming that innovation

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within traditional bioeconomy sectors is primarily interaction-based, incremental, and operationally oriented rather than driven exclusively by formal technological research activities. These findings reinforce the argument that innovation within mature industries develops through collaborative learning, practical adaptation, and coordinated interaction among value-chain participants. The results therefore support the relevance of Doing-Using-Interacting innovation processes in explaining innovation behaviour within traditional bioeconomy industries such as sugar processing in Pakistan. The moderation analysis revealed that Competition and Cost Pressure significantly influence the relationship between governance structures and innovation dynamics. Although coordinated value-chain systems generally enhance innovation performance, excessive economic and market pressures weaken the positive effects of governance coordination by reducing organisational flexibility and limiting long-term investment in innovation activities. This finding highlights the importance of considering broader economic and competitive conditions when evaluating innovation capability within traditional bioeconomy sectors in Pakistan. From a practical perspective, the findings suggest that firms operating within traditional bioeconomy industries should strengthen collaborative governance systems, organisational learning processes, and knowledge-sharing networks in order to improve innovation performance and sustainability outcomes. Policymakers and industry institutions in Pakistan should also support coordination mechanisms, technical collaboration platforms, and innovation-support initiatives that encourage collective learning and sustainability-oriented innovation within the sugar industry and related sectors.

References

Ahmed, J., & Hu, L. (2025). Green Investment, Digital Technological Progress, and the Dynamics of Carbon Emissions in China: A Review. *Journal of Energy and Environmental Policy Options*, *8*(4), 30-39.

Ajayi, O. F., & Akinbobola, T. O. (2025). Bioeconomy and Health Outcomes in Global South: A Case Study of Nigeria. In *Sustainable Bioeconomy Development in the Global South: Volume II Bioeconomy Techniques* (pp. 381-407). Singapore: Springer Nature Singapore.

Online ISSN 3007-3197
Print ISSN 3007-3189

Akim, M. (2020). Analyzing the role of information and communication technology in economic development among OIC nations. *Journal of Policy Options*, *3*(3), 106-113.

Alhusen, H., Bennat, T., Bizer, K., Cantner, U., Horstmann, E., Kalthaus, M., ... & Töpfer, S. (2019). *Measuring the" doing-using-interacting mode" of innovation in SMEs-A qualitative approach* (No. 23/2019). ifh Working Paper.

Ali, M. H., Zailani, S., Iranmanesh, M., & Foroughi, B. (2019). Impacts of environmental factors on waste, energy, and resource management and sustainable performance. *Sustainability*, *11*(8), 2443.

Aliasghar, O., Sadeghi, A., & Rose, E. L. (2023). Process innovation in small-and medium-sized enterprises: The critical roles of external knowledge sourcing and absorptive capacity. *Journal of Small Business Management*, *61*(4), 1583-1610.

Allam, Z., & Cheshmehzangi, A. (2024). Technological innovation and sustainable transitions. In *Sustainable futures and green new deals* (pp. 55-79). Cham: Springer Nature Switzerland.

Ambos, B., Brandl, K., Perri, A., Scalera, V. G., & Van Assche, A. (2021). The nature of innovation in global value chains. *Journal of World Business*, *56*(4), 101221.

Ateeq, A. (2024). Emerging economies and digital transformation: Opportunities and challenges. *Business Sustainability with Artificial Intelligence (AI): Challenges and Opportunities: Volume 1*, 129-136.

Audi, M., Ali, A., & Al-Masri, R. (2022). Determinants of Advancement in Information Communication Technologies and its Prospect under the role of Aggregate and Disaggregate Globalization. *Scientific Annals of Economics and Business*, *69*(2), 191-215.

Ávila, M. M. (2022). Competitive advantage and knowledge absorptive capacity: The mediating role of innovative capability. *Journal of the knowledge economy*, *13*(1), 185-210.

Baah, C., Opoku Agyeman, D., Acquah, I. S. K., Agyabeng-Mensah, Y., Afum, E., Issau, K., ... & Faibil, D. (2022). Effect of information sharing in supply chains: understanding the roles of supply chain visibility, agility, collaboration on supply chain performance. *Benchmarking: An International Journal*, *29*(2), 434-455.

Bauer, F., Hansen, T., & Hellsmark, H. (2018). Innovation in the bioeconomy–dynamics of biorefinery innovation networks. *Technology Analysis & Strategic Management*,

Online ISSN 3007-3197
Print ISSN 3007-3189

30(8), 935-947.

Bibi, C. (2019). Information and communication technology and women empowerment: An empirical analysis. *Journal of Policy Options*, *2*(1), 40-51.

Bodas Freitas, I. M., & Fontana, R. (2018). Formalized problem-solving practices and the effects of collaboration with suppliers on a firm's product innovation performance. *Journal of Product Innovation Management*, *35*(4), 565-587.

Boshkoska, B. M., Liu, S., Zhao, G., Fernandez, A., Gamboa, S., del Pino, M., ... & Chen, H. (2019). A decision support system for evaluation of the knowledge sharing crossing boundaries in agri-food value chains. *Computers in Industry*, *110*, 64-80.

Can, K. (2021). The evolution of communication technologies in Turkey's modern economy. *Journal of Policy Options*, *4*(3), 11-17.

Celik, D., Caneva, S., Ma, C., & SCALE-UP Project Consortium. (2025). Social Innovation for Rural Bioeconomies. *Open Research Europe*, *5*, 30.

Cherwoo, L., Gupta, I., Flora, G., Verma, R., Kapil, M., Arya, S. K., ... & Ashokkumar, V. (2023). Biofuels an alternative to traditional fossil fuels: A comprehensive review. *Sustainable Energy Technologies and Assessments*, *60*, 103503.

Denial, A. (2023). The Role of Innovative Renewable Energy Technologies in Advancing Energy Access in Developing Countries. *Journal of Energy and Environmental Policy Options*, *6*(2), 23-28.

do Prado, G. F., de Souza, J. T., & Piekarski, C. M. (2025). Sustainable and innovative: how can open innovation enhance sustainability practices?. *Sustainability*, *17*(2), 454.

Dooley, L., Barrett, G., & O'Sullivan, D. A. V. I. D. (2022). SME open innovation: differences within the similar across the R&D intensity spectrum. *International Journal of Innovation Management*, *26*(08), 2250060.

Dürr, J., Sili, M., Mac Clay, P., & Sellare, J. (2024). Bioeconomic innovations breeding more sustainable innovations: A value chain perspective from Argentina. *Business Strategy and the Environment*, *33*(7), 6833-6851.

Egea, F. J., López-Rodríguez, M. D., Oña-Burgos, P., Castro, A. J., & Glass, C. R. (2021). Bioeconomy as a transforming driver of intensive greenhouse horticulture in SE Spain. *New Biotechnology*, *61*, 50-56.

Ezekwu, E. (2025). Sustainable supply chain practices: Driving efficiency, reducing waste,

Online ISSN 3007-3197
Print ISSN 3007-3189

and promoting circular economy models. *International Journal of Science and Research Archive*, *14*(1), 1167-1181.

Flor, M. L., Cooper, S. Y., & Oltra, M. J. (2018). External knowledge search, absorptive capacity and radical innovation in high-technology firms. *European management journal*, *36*(2), 183-194.

Gallego-Bono, J. R., & Tapia-Baranda, M. (2022). Industrial ecology and sustainable change: inertia and transformation in Mexican agro-industrial sugarcane clusters. *European Planning Studies*, *30*(7), 1271-1291.

Gawel, E., Pannicke, N., & Hagemann, N. (2019). A path transition towards a bioeconomy—The crucial role of sustainability. *Sustainability*, *11*(11), 3005.

Geda, A. (2023). Advancing Rural Welfare-The Role of Irrigation Technology in Ethiopia's Agricultural Sector. *Journal of Business and Economic Options*, *6*(2), 32-38.

Gerwel Proches, C., & Bodhanya, S. (2015). Exploring stakeholder interactions through the lens of complexity theory: lessons from the sugar industry. *Quality & Quantity*, *49*(6), 2507-2525.

Ghauri, M. A. Z., Mudassar, M., & Audi, M. (2025). From Technology Adoption to Strategic Coherence: The Role of Digitalization in Industrial Growth in Developing Countries. *Qualitative Research Journal for Social Studies*, *2*(3), 392-407.

Golembiewski, B., Sick, N., & Bröring, S. (2015). The emerging research landscape on bioeconomy: What has been done so far and what is essential from a technology and innovation management perspective?. *Innovative Food Science & Emerging Technologies*, *29*, 308-317.

Grohmann, P., Dietze, V., Krämer, C., & Feindt, P. H. (2023). Governance and trust in sustainability-based agri-food value chains. A comparative analysis of five cases in Germany. *Frontiers in Sustainable Food Systems*, *7*, 1130895.

Hädrich, T., Reher, L., & Thomä, J. (2025). Solving the puzzle? An innovation mode perspective on lagging regions. *International Regional Science Review*, *48*(4), 396-436.

Hernández-Espallardo, M., Rodríguez-Orejuela, A., & Sánchez-Pérez, M. (2010). Inter-organizational governance, learning and performance in supply chains. *Supply Chain Management: An International Journal*, *15*(2), 101-114.

Online ISSN 3007-3197
Print ISSN 3007-3189

Hess, M. (2008). Governance, value chains and networks: an afterword. *Economy and Society*, *37*(3), 452-459.

Horvat, D., Dreher, C., & Som, O. (2019). How firms absorb external knowledge—Modelling and managing the absorptive capacity process. *International Journal of Innovation Management*, *23*(01), 1950041.

Iqbal, J., & Noman, M. (2025). Digital Financial Technologies as Drivers of Inclusive Growth: A Strategic Review of Pakistan's Fintech Landscape. *Journal of Business and Economic Options*, *8*(4), 12-22.

Iqbal, Z., & Hayat, M. (2025). Determinants of Financial-Technology Adoption: The Roles of Social Influence and Financial Inclusion in the Banking Sector. *Journal of Business and Economic Options*, *8*(2), 20-30.

Iriarte, L., Fritsche, U., & van Dam, J. (2021). Sustainability governance of bioenergy and the broader bioeconomy. *Technical Paper prepared for IEA Bioenergy Task*, *45*.

Ito, Y., & Zhang, R. (2025). Examining Economic and Technological Drivers of Carbon Dioxide Emissions in Developing Countries: A Policy Perspective. *Journal of Energy and Environmental Policy Options*, *8*(2), 1-12.

Jamel, M., & Zhang, C. (2024). Green finance, financial technology, and environmental innovation impact on CO_2 emissions in developed countries. *Journal of Energy and Environmental Policy Options*, *7*(3), 43-51.

Jiao, H., Yang, J., & Cui, Y. (2022). Institutional pressure and open innovation: the moderating effect of digital knowledge and experience-based knowledge. *Journal of Knowledge Management*, *26*(10), 2499-2527.

Kano, L. (2018). Global value chain governance: A relational perspective. *Journal of International Business Studies*, *49*(6), 684-705.

Kanwal, Z., Audi, M., & Alam, M. (2025). *Corporate Tax Strategy, Risk, and Long-Term Value Creation: Insights from Technology, Pharmaceutical, and Manufacturing Sectors*. University Library of Munich, Germany.

Karhan, G. (2019). Investing in research and development for technological innovation: A strategy for Turkey's economic growth. *Journal of Business and Economic Options*, *2*(4), 152-158.

Khalid, H., Ahmad, K., & Ali, A. (2025). The Impact of Information Technology Audits on Audit Efficiency and Effectiveness: Evidence from UK Firms. *Annual*

Online ISSN 3007-3197
Print ISSN 3007-3189

Methodological Archive Research Review, *3*(4), 511-535.

Krasnokutska, N., Merino, A., Escudero Guirado, C., & Díaz-Carmona, E. M. (2025). Open innovation for sustainability in the agri-food sector: why, who and how?. *European Journal of Innovation Management*, *28*(6), 2532-2557.

Kumar, A., & Gupta, M. (2023). Technological Advancements and Energy Efficiency in Indian Firms. *Journal of Energy and Environmental Policy Options*, *6*(2), 9-16.

Kumar, P., & Wu, H. (2025). Evaluating the dual impact of economic drivers on environmental degradation in developing countries: a study of technology innovation, foreign direct investment, and trade openness. *Journal of Energy and Environmental Policy Options*, *8*(1), 24-36.

Leifer, R. (2000). *Radical innovation: How mature companies can outsmart upstarts*. Harvard Business Press.

Liu, S. (2025). Green management promotes long-term business competitive advantage through the resource-based view. *Total Quality Management & Business Excellence*, *36*(9-10), 946-973.

Liu, S., Chen, Y., Yang, D., & Zhao, C. (2025). How does knowledge sharing create business value in the supply chain platform ecosystem? Unveiling its mediating role in governance mechanisms. *Journal of Knowledge Management*, *29*(7), 2151-2181.

Manta, A. G. (2026). From Sustainability Narratives to Digital Infrastructures: Mapping the Transformation of Smart Agri-Food Systems. *Foods*, *15*(3), 469.

Marc, A., & Ali, A. (2019). *The Advancement in Information and Communication Technologies (ICT) and Economic Development: A Panel Analysis* (No. 93476). University Library of Munich, Germany.

McMillan, G. S., Narin, F., & Deeds, D. L. (2000). An analysis of the critical role of public science in innovation: the case of biotechnology. *Research policy*, *29*(1), 1-8.

McWilliam, S. E., Kim, J. K., Mudambi, R., & Nielsen, B. B. (2020). Global value chain governance: Intersections with international business. *Journal of World Business*, *55*(4), 101067.

Mhlanga, D. (2024). Digital transformation of education, the limitations and prospects of introducing the fourth industrial revolution asynchronous online learning in emerging markets. *Discover education*, *3*(1), 32.

Najda-Janoszka, M., Kajzer-Bonk, J., Milewska, E., & Wrona, S. (2025). Integrating science,

Online ISSN 3007-3197
Print ISSN 3007-3189

technology, and experimental knowledge for sustainable innovation: A Living Lab approach to urban biodiversity management. *Journal of Entrepreneurship, Management and Innovation*, *21*(2), 33-55.

Ogwu, M. C., Kosoe, E. A., & Osawaru, M. E. (2025). Raw materials for sustainable bioeconomy development in the global south. In *Sustainable Bioeconomy Development in the Global South: Volume I Status and Perspectives* (pp. 37-63). Singapore: Springer Nature Singapore.

Owusu, F., & Novignon, J. (2021). Exploring the benefits and challenges of mobile technology in Ghanaian small-scale enterprises. *Journal of Policy Options*, *4*(1), 23-29.

Pilbeam, C., Alvarez, G., & Wilson, H. (2012). The governance of supply networks: a systematic literature review. *Supply Chain Management: an international journal*, *17*(4), 358-376.

Piot-Lepetit, I. (2023). Digitainability and open innovation: how they change innovation processes and strategies in the agrifood sector?. *Frontiers in Sustainable Food Systems*, *7*, 1267346.

Ponte, S., Sturgeon, T. J., & Dallas, M. P. (2019). Governance and power in global value chains. In *Handbook on global value chains* (pp. 120-137). Edward Elgar Publishing.

Poponi, S., Arcese, G., Mosconi, E. M., Pacchera, F., Martucci, O., & Elmo, G. C. (2021). Multi-actor governance for a circular economy in the agri-food sector: bio-districts. *Sustainability*, *13*(9), 4718.

Prajogo, D. I., McDermott, P., & Goh, M. (2008). Impact of value chain activities on quality and innovation. *International Journal of Operations & Production Management*, *28*(7), 615-635.

Prakash, C., & Ali, S. (2026). Governance under volatility: how contracts and trust shape opportunism in humanitarian operations. *Journal of Humanitarian Logistics and Supply Chain Management*, 1-13.

Qin, L., & Sun, S. L. (2026). Knowledge dependence in global value chains. *Research Policy*, *55*(2), 105392.

Quazi, A., & Talukder, M. (2011). Demographic determinants of adoption of technological innovation. *Journal of Computer Information Systems*, *52*(1), 34-42.

Rana, H. A., Audi, M., & Ali, A. (2025). Determinants of Cryptocurrency Adoption: A Cross-

Online ISSN 3007-3197
Print ISSN 3007-3189

Country Analysis of Economic, Technological, and Institutional Factors. *Journal of Social Signs Review*, *3*(8), 58–76.

Rees, W. E. (2021). Achieving sustainability: reform or transformation?. In *The Earthscan reader in sustainable cities* (pp. 22-52). Routledge.

Rivera, L., & Moreno, G. (2024). Trust as an Enhancer of Collaborative Value Creation An Approach to Digital Supply Chain Collaboration in Developing Countries. In *Citizenship, Culture and Coexistence* (pp. 41-61). CRC Press.

Salleh, I., & Sapengin, F. (2023). Exploring the impact of technological capability on inter-firm relationships in Malaysian manufacturing supply chains. *Journal of Policy Options*, *6*(4), 40-48.

Sgroi, F. (2022). Cooperation and innovation in Italian agribusiness between theoretical analysis and empirical evidence. *Journal of agriculture and food research*, *10*, 100406.

Shang, J., Zhang, J., Xia, N., Zhang, S., Li, G., & Ye, X. (2026). University–industry collaborative innovation, corporate dynamic capabilities and carbon reduction. *International Journal of Sustainability in Higher Education*, 1-23.

Shi, Q., Wang, Q., & Guo, Z. (2022). Knowledge sharing in the construction supply chain: Collaborative innovation activities and BIM application on innovation performance. *Engineering, Construction and Architectural Management*, *29*(9), 3439-3459.

Siklar, B., Akcakaya, Y., Halaç, H. H., & Bademci, F. (2026). Rethinking Governance in Transboundary Serial World Heritage Sites: Multi-Level Coordination, Institutional Diversity, and Cultural Diplomacy. *Systems*, *14*(2), 220.

Simboli, A., Taddeo, R., & Morgante, A. (2014). Value and wastes in manufacturing. An overview and a new perspective based on eco-efficiency. *Administrative Sciences*, *4*(3), 173-191.

Solomon, S. (2016). Sugarcane production and development of sugar industry in India. *Sugar Tech*, *18*(6), 588-602.

Song, H., Liu, J., & Chen, G. (2013). Tourism value chain governance: Review and prospects. *Journal of travel research*, *52*(1), 15-28.

Song, W., & Zhao, K. (2024). Navigating the innovation policy dilemma: How subnational governments balance expenditure competition pressures and long-term innovation goals. *Heliyon*, *10*(15).

Stavar, D. (2025). Machine Learning versus Traditional Statistical Models in Credit Risk

Online ISSN 3007-3197
Print ISSN 3007-3189

Prediction: Evidence from Peer-to-Peer Lending Markets. *Journal of Policy Options*, *8*(4), 35-44.

Tila, G., & Cera, D. (2021). Information and Communication Technologies Integration and Usage Patterns Among University Students. *Journal of Policy Options*, *4*(1), 1-6.

Trantopoulos, K., von Krogh, G., Wallin, M. W., & Woerter, M. (2017). External Knowledge and Information Technology: Implications for Process Innovation Performance1. *MIS quarterly*, *41*(1), 287-300.

Ullah, Z., Iqbal, J., Abbasi, B. A., Ali, I., Ijaz, S., Yaseen, T., ... & Mahmood, T. (2025). Global Food Security and Bioenergy Production. In *Forage Crops in the Bioenergy Revolution: From Fields to Fuel* (pp. 15-48). Singapore: Springer Nature Singapore.

van Zanden, J. L. (2023). Examining the relationship of information and communication technology and financial access in Africa. *Journal of Business and Economic Options*, *6*(3), 26-36.

Venturelli, A., Caputo, A., Pizzi, S., & Valenza, G. (2022). A dynamic framework for sustainable open innovation in the food industry. *British Food Journal*, *124*(6), 1895-1911.

Vurro, C., Russo, A., & Perrini, F. (2009). Shaping sustainable value chains: Network determinants of supply chain governance models. *Journal of business ethics*, *90*(Suppl 4), 607-621.

Wang, C., & Hu, Q. (2020). Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance. *Technovation*, *94*, 102010.

Wang, M. C., Chen, P. C., & Fang, S. C. (2018). A critical view of knowledge networks and innovation performance: The mediation role of firms' knowledge integration capability. *Journal of Business Research*, *88*, 222-233.

Wang, T., Yu, Z., Ahmad, R., Riaz, S., Khan, K. U., Siyal, S., ... & Zhang, T. (2022). Transition of bioeconomy as a key concept for the agriculture and agribusiness development: An extensive review on ASEAN countries. *Frontiers in Sustainable Food Systems*, *6*, 998594.

Wang, Y., & Zhou, Y. (2023). Innovation network, knowledge absorption ability, and technology innovation performance: An empirical analysis of China's intelligent manufacturing industry. *Plos one*, *18*(11), e0293429.

Online ISSN 3007-3197
Print ISSN 3007-3189

William, C. (2021). Enhancing urban transport environmental performance with technology and innovation. *Journal of Energy and Environmental Policy Options*, *4*(3), 28-33.

Yeung, C., & Chung, L. (2025). Technology, Institutions, and Longevity: An Empirical Analysis of AI Investment and Life Expectancy in the OECD. *Journal of Policy Options*, *8*(3), 17-29.

Zartha Sossa, J. W., Gutiérrez Posada, N., Zuluaga Monsalve, A. M., Botero Montoya, L. H., Gutiérrez Cano, L. F., González Candia, J. & Escobar Mora, N. J. (2025). Sustainable Innovation Management Model (MGI) for Plantain Agroindustrial Chain. *Sustainability*, *17*(4), 1716.

Zhang, J., & Wu, J. (2020). A Discussion on Innovative Techniques for Improving Soil Load-Bearing Capacity. *Journal of Energy and Environmental Policy Options*, *3*(3), 78-85.

Zhao, G., Hormazabal, J. H., Elgueta, S., Manzur, J. P., Liu, S., Chen, H., ... & Chen, X. (2021). The impact of knowledge governance mechanisms on supply chain performance: empirical evidence from the agri-food industry. *Production Planning & Control*, *32*(15), 1313-1336.