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2026 Volume 4, Issue 2
Educational Innovation Research
ISSN: 3029-1844(Print) ISSN: 3029-1852(Online)

Innovation Ecosystem Green Value Co Creation: Conceptual Connotation and Behavioral Model

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Abstract: Currently, green value co-creation has emerged as a pivotal approach to overcoming resource and environmental constraints while driving high-quality development. Grounded in innovation ecosystem theory and green development theory, this paper systematically defines the conceptual framework of green value co-creation within innovation ecosystems. It identifies practical challenges in implementing co-creation models and proposes actionable strategies, including enhancing stakeholder collaboration, building consensus on green co-creation, optimizing categorized models, improving operational efficiency, and refining value realization and distribution mechanisms. These measures aim to translate green value co-creation from theory to practice, thereby providing pathways and support for the green transformation of innovation ecosystems.

Keywords: innovation ecosystem; green value co-creation; conceptual connotation; behavioral pattern

Online publication: February 26, 2026

1. Introduction

Against the backdrop of global carbon neutrality goals and China's "dual carbon" strategy advancing, the synergy between economic development and ecological conservation has become a critical issue in high-quality development. Traditional innovation models, centered on individual enterprises and linear value chains, focus on technological breakthroughs and economic benefits. However, they struggle to effectively address systemic challenges such as tightening resource constraints, escalating environmental risks, and diversified stakeholder demands. As an open, collaborative, and dynamically evolving complex network, the innovation ecosystem provides a crucial theoretical framework and practical pathway for transcending organizational boundaries, integrating multi-stakeholder resources, and achieving sustainable value creation. Embedding green development principles throughout the entire operation of innovation ecosystems and promoting green value co-creation represent an inevitable choice for transitioning innovation paradigms toward ecological, low-carbon, and circular development. Therefore, in the future, it is essential to systematically define the core essence, constituent dimensions, and essential characteristics of green value co-creation, identify and refine collaborative behavior types and operational mechanisms among multiple stakeholders, and enrich interdisciplinary research findings on innovation ecosystems and green development.

2. Theoretical basis and literature review

2.1. Definition of Core Concepts

An innovation ecosystem is a complex adaptive system comprising core enterprises, suppliers, research institutions, governments, and users. Guided by collaborative innovation, it achieves value creation and equitable distribution through resource sharing, complementary strengths, and symbiotic evolution. Operating on networked interactions and multi-stakeholder collaboration, this system features core enterprises as resource integrators and strategic leaders, research institutions as technology providers and knowledge contributors, governments as policy enforcers and institutional supporters, and users as active participants in demand feedback and value validation. Through division of labor and cooperation, all entities form a co-evolving innovation community.

Green value co-creation is a dynamic process where multiple stakeholders collaborate to achieve green innovation goals through resource integration and knowledge sharing, equitably distributing economic, environmental, and social values. Economic value focuses on cost reduction, efficiency enhancement, and premium pricing for green products. Environmental value emphasizes emission reduction, energy conservation, pollution control, and resource recycling. Social value is reflected in improved collective welfare and the promotion of sustainable development concepts. Unlike traditional single-value creation logic, this three-dimensional approach transforms ecological constraints into innovation drivers, achieving economic, ecological, and social benefits.

The green value co-creation behavioral model in innovative ecosystems represents a stable framework and interactive structure for value creation activities among multiple stakeholders within green innovation scenarios. Guided by green objectives, this model employs collaborative interaction as its pathway and value sharing as its safeguard. It clearly defines the functional boundaries and participation modes of each entity across R&D, production, consumption, and governance phases, standardizes the flow and allocation of green innovation resources including technology, knowledge, data, and capital, and establishes a replicable operational paradigm. This model provides behavioral guidance and institutional support for achieving systematic green value co-creation.

2.2. Basic Theory

The innovation ecosystem theory highlights a complex symbiotic network formed by multiple stakeholders, including enterprises, universities, research institutions, and governments. These entities utilize complementary resources and collaborative evolution to form an organic whole. Core enterprises play pivotal roles in resource integration, relationship coordination, and strategic guidance, driving the transition toward open collaboration in innovation models. This theory provides valuable insights into the networked structure of green value co-creation.

The Green Development Theory, with sustainable development as its core objective, seeks to achieve economic, environmental, and social benefits. It emphasizes improving resource efficiency, controlling pollution sources, protecting ecosystems, and aligning these efforts with enhancing human well-being. This theory charts the course for innovative ecosystems to transition from single-minded pursuit of economic growth to green and low-carbon development.

3. The Practice Dilemma of Green Value Co-creation Behavior Model in Innovation Ecosystem

3.1. The Dilemma of Entity Coordination

These are the key challenges in green value co-creation within innovation ecosystems, primarily manifested in the following aspects:

First, the significant differences in demands among multiple stakeholders make it challenging to establish unified consensus goals. Green value co-creation involves multiple parties, including enterprises, governments, and the public, each with distinct core priorities. As market entities, enterprises primarily focus on economic efficiency, but the high costs

and limited returns of green innovation investments deter their participation. Governments prioritize public interests, concentrating on achieving green and low-carbon targets and improving ecological environments through public welfare-oriented approaches. The public emphasizes the convenience of green participation and rights protection, yet their demands remain fragmented and lack systematic coordination. These misaligned needs hinder collaborative synergy. Second, small and medium-sized enterprises (SMEs) exhibit weak green innovation capabilities, making it difficult for them to integrate into high-end innovation ecosystems. Green innovation requires substantial resources such as funding, technology, and talent, which SMEs often lack due to insufficient reserves. Compared to large enterprises, SMEs demonstrate significant gaps in green technology R&D and carbon management capabilities, limiting their ability to engage in high-end green innovation collaborations and resulting in insufficient ecosystem coverage. Third, information asymmetry among stakeholders and the absence of sharing mechanisms pose challenges. Whether it's green technology achievements, carbon emission data, or market demand information, these resources are concentrated in a few large enterprises and government departments, lacking transparent sharing channels. Inadequate disclosure of government policies and data further hinders public access to green information, making it difficult for stakeholders to precisely align their needs and ultimately reducing the efficiency of green value co-creation.

3.2. Operational Dilemma of the Model

In the co-creation of green value within innovation ecosystems, operational challenges in models may compromise both efficiency and quality. Currently, mainstream models including contractual, relational, platform-based, and negotiated approaches all exhibit limitations that hinder the transformation of green value. These issues are primarily manifested as follows:

First, the contractual model demonstrates inadequate enforcement efficacy. While designed to regulate stakeholder behavior, its inherent uncertainty in green innovation makes it difficult to cover all scenarios, resulting in significant limitations. Moreover, defining breaches in green co-creation initiatives proves challenging, compounded by the absence of effective monitoring mechanisms. This renders contractual clauses superficial, undermining the smooth implementation of collaborative efforts. Second, the platform-based model faces digital divide challenges and uneven empowerment effectiveness. As essential platforms for resource integration and empowerment, they struggle to reach small and medium-sized entities with limited digital capabilities and financial constraints, hindering access to green technologies and carbon data resources. Third, the consultative model suffers from inefficient decision-making and sluggish value conversion. Although requiring multi-stakeholder collaboration, the divergent interests among participants complicate coordination, leading to prolonged decision cycles and low operational efficiency.

3.3. The Dilemma of Value Realization

The realization of green value is the main goal of green value co-creation in innovation ecosystem.

Firstly, environmental value is difficult to quantify, and the mechanism for realizing the value of ecological products remains imperfect. Environmental benefits serve as the core industry in green value co-creation, yet intangible environmental values such as air purification, carbon reduction, and biodiversity conservation lack unified quantification indicators and accounting methods, making it challenging to accurately measure their economic value. Meanwhile, the ecological product trading market is underdeveloped with inadequate pricing mechanisms, hindering the conversion of environmental value into tangible benefits through market transactions. This results in insufficient motivation for stakeholders to participate in green co-creation. Secondly, value distribution is imbalanced, with insufficient returns for supporting entities. In green value co-creation practices, core enterprises dominate most benefits from green innovation achievements by leveraging technological, financial, and resource advantages. However, upstream and downstream supporting enterprises, research institutions, and public stakeholders—despite their active participation in green innovation R&D, promotion, and implementation—struggle to receive returns commensurate with their contributions. Such distribution affects the enthusiasm of non-core participants. Thirdly, the diffusion of green technologies is slow,

and the efficiency of industry-academia-research collaboration remains low. The implementation of green innovation outcomes primarily relies on the widespread dissemination and transformation of technologies. However, the current industry-academia-research collaboration mechanism is imperfect, with green technology R&D by scientific institutions disconnected from actual corporate needs, lacking effective technology transfer channels.

3.4. The Dilemma of the Safeguard Mechanism

The safeguard mechanism serves as the primary pillar for fostering green value co-creation within innovation ecosystems. However, it currently faces challenges that undermine the stability of such collaborative efforts, hindering their sustainable development.

Firstly, the green policy framework remains underdeveloped with insufficient targeted support measures. Current green policies predominantly rely on macro-level guidance, lacking differentiated designs. Subsidies, tax incentives, and financial support policies exhibit narrow coverage. Tax preferential policies mainly favor large core enterprises, leaving supporting entities struggling to benefit. The limited variety of green financial products fails to meet diverse financing needs, hindering collaborative innovation efforts. Secondly, green standards, carbon accounting, and ecological compensation systems lack uniformity. In the field of green innovation, there is no nationally unified standard for green products or carbon emission calculation methods, resulting in significant regional and industry disparities. This hinders the cross-regional and cross-industry application of green innovation achievements. Meanwhile, the ecological compensation system remains incomplete with single compensation methods, failing to protect the legitimate rights of ecological conservationists and impeding the advancement of green value co-creation. Thirdly, insufficient public awareness and low participation enthusiasm exist. Some enterprises prioritize economic benefits over green innovation investments due to inadequate recognition of collaborative green value. The public demonstrates limited green consumption awareness and environmental participation consciousness, with narrow channels for green value co-creation. These factors create an unfavorable environment, leading to a lack of broad social foundation for green value co-creation.

4. Optimization Path of Green Value Co-creation Behavior Model in Innovation Ecosystem

4.1. Enhancing Collaborative Efforts to Build Consensus for Green Co-creation

The core driving force of green value co-creation in innovation ecosystem is the collaboration of main body. It is necessary to strengthen the main body as an important starting point, build communication platform, establish information sharing mechanism, gather consensus of green co-creation, promote green value co-creation, and build the main body foundation for green development of innovation ecosystem.

The first step involves establishing a multi-stakeholder communication platform and implementing a regular consultation mechanism to align green value objectives. Specifically, during platform development, it is essential to address the significant differences in demands among enterprises, governments, and the public by breaking down communication barriers between stakeholders[1]. The platform should periodically organize consultation meetings involving government departments, core enterprises, small and medium-sized entities, and research institutions. These meetings should focus on key issues such as green innovation directions and resource allocation, while actively listening to the perspectives of all parties. Concurrently, a regular feedback mechanism should be established to refine and implement the consensus reached through consultations. This ensures the integration of corporate economic benefits, government public welfare guidance, and public participation needs, ultimately forming a unified green value objective and fostering collaborative synergy.

Second, enhance green empowerment for small and medium-sized enterprises (SMEs) by providing technical training, financial support, and resource coordination to facilitate their integration into the green co-creation ecosystem. Specifically, the government should lead collaboration with core enterprises and research institutions to conduct comprehensive green technology training across multiple domains, including green R&D, carbon management, and environmental technology

applications, thereby boosting SMEs' green innovation capabilities[2]. Financial policies should be optimized by expanding green subsidy coverage, lowering application thresholds, and introducing tailored green credit products for SMEs to alleviate their funding pressures.

Third, establish a green information sharing platform to break down information barriers and achieve transparency in carbon data and technical information. During implementation, digital technologies should be utilized to integrate various green information resources. The platform should cover multiple aspects, including green technology achievements, carbon emission accounting data, and green market demand, with clear information disclosure standards to encourage proactive data uploads and real-time updates by government and enterprises. Additionally, an information security mechanism should be established to regulate access permissions, protect core technological privacy, and ensure orderly information sharing. Through this platform, all stakeholders can fully understand green innovation trends, carbon reduction requirements, and market demands, enabling technical complementarity and resource interoperability to enhance collaborative efficiency.

4.2. Classification Optimization Mode to Improve Operational Efficiency

To ensure the efficient advancement of green value co-creation, it is essential to implement categorized optimization strategies based on the core pain points of various models, resolve operational challenges, refine the operational mechanisms, guarantee the quality of green value co-creation, and promote the sustainable development of co-creation models.

First, optimize the contractual model to strengthen institutional safeguards and enhance enforcement effectiveness. Refine green contract clauses by addressing uncertainties in green innovation, detailing green technology applications, carbon reduction targets, and environmental responsibility allocation, while clearly defining the rights and obligations of all parties. Establish a contract enforcement supervision mechanism involving third-party institutions to monitor contract implementation throughout the process, ensuring compliance and standardizing collaborative behaviors. Second, optimize the relational model to cultivate trust systems and stabilize cooperative networks[3]. Develop a green co-creation reputation evaluation system that incorporates parties' performance in cooperation, contributions to green innovation, and environmental responsibility fulfillment. Publicly disclose evaluation results to create positive incentives and negative constraints. Through this reputation system, select entities with strong collaboration willingness to integrate into core cooperative networks, deepening partnerships and ensuring the stability of the relational model. Third, optimize the platform model to narrow the digital divide. Lower platform entry barriers, simplify onboarding processes for small and medium-sized entities, and break the monopoly of large entities on platform resources. Simultaneously, enhance platform functionality to meet the green innovation needs of small and medium-sized entities, integrating technological, financial, and market resources. Provide customized empowerment services tailored for these entities to access green innovation resources. Fourth, optimize the consultative model to improve decision-making efficiency. Establish a revenue-sharing mechanism that balances the reasonable demands of all stakeholders, leveraging profit-sharing approaches to build consensus through negotiation.

4.3. Improving the Mechanism of Value Realization and Distribution

The realization of green value is the primary goal of value co-creation in innovation ecosystems. It requires a comprehensive focus on the entire value realization process, including establishing a robust ecological product value accounting system, formulating equitable value distribution mechanisms, and facilitating technology transfer channels. These measures aim to unleash green value and promote the green co-creation development of innovation ecosystems.

First, establish an ecological product value accounting system. During implementation, define core indicators and methodologies for environmental values such as air purification, carbon reduction, and biodiversity conservation to achieve precise quantification. Refine accounting principles to ensure scientific validity of results. Second, develop a fair value distribution mechanism based on contribution, while safeguarding vulnerable stakeholders 'interests[4]. Specifically, clarify each entity's contribution to green value co-creation, ensuring that green innovation outcomes and contributions

are accurately matched. Prioritize vulnerable groups by providing special subsidies to offset their input costs and protect their legitimate rights. Third, streamline green technology transfer channels and strengthen industry-academia-research collaboration. Research institutions should focus on enterprise-specific needs to develop green technologies, while enterprises, as market players, should connect with research resources and take primary responsibility for technology transfer[5].

4.4. Enhancing the Safeguard System and Strengthening Institutional Support

This serves as the cornerstone for the sustainable advancement of green value co-creation within innovation ecosystems. It requires prioritizing the development of safeguard mechanisms by refining relevant policies and regulations, standardizing institutional frameworks, and solidifying the institutional foundation for green value co-creation to motivate diverse stakeholders to participate.

First, the government should establish a comprehensive green policy and legal framework, clearly defining the environmental responsibilities of all stakeholders and strengthening legal constraints. It should improve green tax incentives by offering tax reductions for green innovation enterprises and eco-friendly projects, thereby reducing corporate costs for green investments. Second, unified green standards, carbon accounting systems, and ecological compensation mechanisms should be implemented to regulate corporate behavior and ensure coordinated progress. A nationally unified green standard system should be established, with clear requirements for green products, technologies, and production processes. This will achieve cross-regional and cross-industry standardization, facilitating the standardized promotion of green innovation achievements. Third, through diverse channels including short videos and special reports, the public should be educated about the contemporary significance of green innovation and low-carbon development via mainstream media and new media platforms. The core concepts and practical approaches of green value co-creation should be explained. Enterprises should be guided to embrace green development concepts, using policy briefings and case studies to help them recognize the importance of green innovation. This will encourage proactive engagement in green technology R&D and product innovation, fostering active participation in green value co-creation and creating a collaborative societal momentum.

5. Conclusion

In summary, the green value co-creation behavioral model of innovation ecosystems, through differentiated operational approaches categorized as contractual, relational, platform-based, and negotiated models, provides actionable pathways for multi-stakeholder participation in green co-creation supported by closed-loop mechanisms, ensuring the effective implementation of green value co-creation activities. Moving forward, as green development strategies continue to deepen, we will further optimize the behavioral model of green value co-creation within innovation ecosystems, enhance multi-stakeholder collaboration, strengthen institutional safeguards, and achieve the sustainable development of green value co-creation models.

Funding

Project: University Basic Scientific Research Project of the Education Department of Liaoning Province, 2024

Project name: Research on the Impact of Digital Transformation of Manufacturing Enterprises on Innovation Performance (Project No.: LJ112413217003)

Disclosure statement

The author declares no conflict of interest.

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