

Research on Countermeasures for Complementary Cooperative Innovation Partner Selection of New-Material Enterprises under the Background of Economic Globalization

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Abstract

The construction of a partner-selection system for complementary cooperative innovation among new-material enterprises serves as a critical exploration that meets the demands of industrial innovation and development. Nevertheless, numerous practical issues closely tied to industrial development characteristics persist in its advancement. The practical difficulties in selecting complementary cooperative innovation partners for new-material enterprises constitute challenges that all innovation entities must confront when carrying out collaborative cooperation. Their causes include practical-level problems such as poor industrial adaptability of multi-attribute decision-making methods and the absence of conflict-response mechanisms for partner selection in industrial alliances, as well as institutional-level problems whereby cross-regional partner selection fails to give full play to the efficiency of market integration. On the basis of sorting out the construction status including evaluation dimensions, application scenarios and research practices of complementary cooperative innovation partner selection for new-material enterprises, this paper adopts an innovation-management perspective and centers on the individual advantages of enterprises' innovation capabilities. It analyzes existing problems concerning complementary cooperative innovation partner selection for new-material enterprises from the perspectives of evaluation methods, management-and-control mechanisms and partner-selection systems. Combined with cutting-edge achievements in relevant disciplines in this industry, this paper puts forward systematic countermeasures: intelligently reconstruct multi-attribute comprehensive evaluation methods, build a full-process conflict management-and-control mechanism for alliance partner selection, develop a cross-regional partner-selection system relying on a unified national large-scale market, and proactively lay out supporting ecosystems for partner selection. These efforts aim to promote the overall optimization of the complementary cooperative innovation partner-selection system for new-material enterprises.

Keywords

New-material Enterprises; Complementary Cooperation; Cooperative Innovation; Partner Selection.

1. Introduction

Against the backdrop of economic globalization, innovation demands across various industries keep escalating, inherent limitations exist in enterprises' internal resources, and practical appeals for collaborative development among innovation entities are expanding. As a result, the traditional single-model innovation can hardly satisfy the diverse demands of market competition and industrial upgrading. Hence, innovative cooperation has become a vital

measure for enterprises to break through development bottlenecks[1]. As a key factor for successful cooperative innovation, the evaluation system for innovation-partner selection has evolved from a single dimension of resource matching to a multi-dimensional system covering technical-background similarity[1], resource complementarity[2], cooperative regional synergy[3], and multi-attribute comprehensive evaluation[4]. Scientific screening of cooperative innovation partners is of great significance for forming efficient innovation consortia and serving the national strategy of high-level self-reliance and self-improvement in science and technology. Therefore, establishing scientific and objective methods for innovation-partner selection that fit enterprises' innovation-development demands has become a critical issue to be resolved in the development of new-material enterprises.

2. Construction Status of Complementary Cooperative Innovation Partner Selection for New-Material Enterprises

2.1. Multi-dimensional Construction of the Complementary Partner-selection Evaluation System

Centering on the core requirement of resource complementarity, the evaluation system for complementary cooperative innovation partner selection of new-material enterprises has built a multi-dimensional and comprehensive evaluation framework covering key complementary elements for enterprise innovation and development[2]. Its core evaluation dimensions are specified as follows. First, full-dimensional resource complementarity evaluation. A systematic evaluation indicator system is constructed from four dimensions: knowledge resources, technical resources, market resources and environmental resources. It can comprehensively measure the resource heterogeneity and complementarity between candidate partners and new-material enterprises. The rough-set method is adopted to scientifically determine the weight of each indicator, which fully reflects decision-makers' actual perception of demands for complementary resources. It acts as the core evaluation basis for new-material enterprises to screen complementary partners[2]. Second, technical-background complementarity evaluation. Taking patent data as the core carrier, quantitative calculation is conducted on the technical-background similarity among innovation entities, so as to accurately measure the technical compatibility and complementary potential between different new-material enterprises and innovation entities. It provides quantifiable evaluation criteria for selecting complementary cooperative innovation partners for new-material enterprises in terms of technical resources[1]. Third, regional-synergy complementarity evaluation. The market-integration effect under government coordination is incorporated into evaluation considerations, and the complementarity of regional industrial resource layout is taken into account. It has been verified that enterprises within the same regional market-integration coordination system achieve significantly improved complementary cooperation effects, adding a regional-synergy evaluation perspective for new-material enterprises to select complementary cooperative innovation partners across regions[3].

2.2. Expanding Application Scenarios for Complementary Partner Selection

The application scenarios for complementary cooperative innovation partner selection of new-material enterprises have gradually extended from bilateral cooperation between individual enterprises to diverse cooperation forms such as industrial alliances and innovation consortia, satisfying complementary cooperation demands at different levels of the new-material industry[5]. First, complementary partner selection for innovation consortia. Oriented toward the strategic requirement of high-level self-reliance and self-improvement in science and technology for the new-material sector, complementary partner selection is implemented in the construction of innovation consortia. Through accurate complementary

integration of technologies and resources, the collaborative-innovation advantages of innovation consortia can be exerted. Relevant partner-selection methods have been applied in building polymer-material innovation consortia[1]. Second, complementary partner selection for industrial technology-innovation alliances. Targeting the establishment demands of new-material industrial technology-innovation alliances and considering their characteristics of co-existing competition and cooperation, diversity and dynamics, complementary partner selection helps resolve intra-alliance problems including resource mismatch and inefficient cooperation. Complementary screening of partners serves as the core key to the successful operation of new-material industrial technology-innovation alliances[4]. Third, cross-regional complementary-cooperation partner selection. Via government-led regional market-integration mechanisms, new-material enterprises can select cross-regional innovation partners with strong complementary resources, technologies and markets. Leveraging the creation effect of market integration, the efficiency and performance of cross-regional complementary cooperative innovation can be enhanced[3].

2.3. Gradual Advancement of Targeted Research and Practical Exploration

Targeted research and practices concerning complementary cooperative innovation partner selection for new-material enterprises are shifting from learning methods from traditional manufacturing sectors toward approaches adapted to the characteristics of the new-material industry[1]. Existing studies have taken polymer materials, a core subdivision of new materials, as empirical objects to carry out special practices for complementary cooperative innovation partner selection. They accurately depict potential complementary-cooperation relationships among innovation entities in this field and realize clustering of innovation entities with highly complementary technical backgrounds, offering direct practical references for other new-material subdivisions[1]. Meanwhile, research outcomes such as resource-complementarity indicator systems and multi-attribute decision-making models built for traditional manufacturing enterprises are being progressively adapted and applied to new-material enterprises. They supply important theoretical and methodological support for new-material enterprises to optimize and improve their complementary cooperative innovation partner-selection systems in light of their own industrial and technical features[2,4]. In addition, relevant research reviews under the open-innovation background clarify common deficiencies in current studies on complementary innovation-partner selection, pointing out directions for subsequent special research on complementary partner selection adapted to the features of the new-material industry[6].

3. Existing Problems

3.1. Weak Industrial Adaptability of Multi-attribute Decision-making Methods

Existing multi-attribute decision-making models provide comprehensive evaluation approaches for complementary partner selection of manufacturing-industry enterprises, yet no targeted optimization combining industrial characteristics has been conducted when they are applied to new-material enterprises. The new-material industry features long research-and-development cycles, high innovation risks and strong technical professionalism, imposing special requirements for indicator weight assignment, information screening and result judgment in partner-selection evaluation. Nevertheless, existing consistency-based comprehensive evaluation methods fail to adjust weight distribution of evaluation dimensions and information-integration modes. They cannot accurately capture core evaluation factors for new-material enterprises' partner selection and show insufficient capacity to handle fuzzy information peculiar to this industry. Consequently, evaluation results poorly match enterprises' actual partner-selection demands, with limited scientific validity and guiding value.

3.2. Lack of Conflict-response Mechanisms for Partner Selection in Industrial Alliances

Industrial technology-innovation alliances constitute an important scenario for complementary cooperative innovation of new-material enterprises. Such alliances are featured by co-existing competition and cooperation and frequent conflicts. However, current alliance partner-selection strategies merely focus on screening partners' complementarity, without taking potential cooperation-conflict risks into consideration or establishing supporting mechanisms for conflict prediction and resolution. Complementary cooperation among new-material enterprises involves integration of key elements including core technologies, R&D resources and market channels, which may easily trigger conflicts over benefit distribution, resource input and technology ownership. The absence of conflict considerations in the partner-selection phase may lead to selected partners who possess resource complementarity yet lack foundations for conflict coordination. This undermines the stability and sustainability of alliance cooperation and reduces the overall efficiency of complementary cooperative innovation.

3.3. Insufficient Utilization of Market Integration in Cross-regional Partner Selection

Government-coordinated market integration provides important institutional support for cross-regional complementary partner selection of new-material enterprises. Still, current cross-regional partner-selection practices only focus on cooperation selection among enterprises within the same market-integration coordination system. They fail to fully tap the creation effect of market integration and dig deep into inter-regional resource heterogeneity and complementarity. When selecting cross-regional partners, some new-material enterprises lack systematic analysis of regional industrial policies, resource layouts and technical features, and cannot formulate targeted partner-selection strategies in accordance with the regional-synergy characteristics of market integration. Meanwhile, affected by the diversion effect of market integration, resource circulation and collaboration efficiency between cross-regional partners remain low. Inter-regional resource-complementarity advantages cannot be fully unlocked, and the performance of cross-regional complementary cooperative innovation falls short of expectations.

4. Countermeasures and Suggestions

In response to the above-mentioned existing problems, based on the cutting-edge progress of innovation management and digital-intelligent transformation, this paper constructs a four-in-one countermeasure system of "method upgrading - mechanism reconstruction - market integration - ecological support". Cutting-edge technologies such as artificial intelligence shall be adopted to improve the industrial adaptability of multi-attribute decision-making methods; contract governance and digital-trust mechanisms shall resolve conflict-governance dilemmas of industrial alliances; a unified national large-scale market and factor-market-oriented allocation shall fully release the market-integration efficiency of cross-regional partner selection; forward-looking construction of supporting ecosystems shall consolidate the institutional and technical foundations for complementary partner selection. These countermeasures are inter-connected and progressive, offering operable and implementable guidelines for new-material enterprises to carry out complementary cooperative innovation, and jointly promoting the overall optimization of their complementary cooperative innovation partner-selection systems.

4.1. Intelligently Reconstruct Multi-attribute Comprehensive Evaluation Methods to Enhance Industrial Adaptability

To address the problem of weak industrial adaptability of multi-attribute decision-making methods, new-generation information technologies including artificial intelligence, machine learning and knowledge graphs shall be systematically embedded into multi-attribute comprehensive evaluation methods in compliance with the intelligent and digital-intelligent development frontier of decision-making science, realizing the transformation from “general adaptation” to “industry-specific customization”. First, reconstruct industry-specific evaluation indicator systems. While retaining core dimensions such as resource complementarity and technical-background similarity, industry-specific indicators including technical maturity, R&D sustainability, achievement-transformation potential and green-low-carbon attributes shall be added in light of new-material industry characteristics such as long R&D cycles, high innovation risks, strong technical professionalism and rapid iteration speed. General indicators disconnected from industrial realities shall be eliminated to build a three-in-one evaluation indicator system of “data + algorithm + scenario”. Second, improve processing capacity for fuzzy evaluation information. Frontier approaches for expressing and processing uncertain information such as hesitant fuzzy sets and intuitionistic fuzzy sets shall be introduced to optimize algorithm logic for consistent comprehensive evaluation. Machine-learning algorithms shall be applied to cluster, profile and intelligently screen candidate partners’ data including patents, papers, standards and operational information. Large-language models and knowledge graphs shall be leveraged to extract and fuse massive heterogeneous data, building multi-dimensional “digital profiles” of candidate partners covering technology, resources and markets, so as to provide high-quality data foundations for indicator assignment and information screening. Meanwhile, the interpretability of classical methods such as analytic hierarchy process in decision-making logic shall be maintained, and the human-machine collaborative decision-making mode of “expert experience + artificial intelligence” shall be explored, so as to improve evaluation efficiency while guaranteeing transparency and traceability of the decision-making process. Third, establish differentiated dynamic weight and iterative-calibration mechanisms. Differentiated indicator weights shall be set according to technical differences and partner-selection demands of subdivisions such as polymer materials, advanced ceramics, rare-earth functional materials and new-energy materials. Taking post-selection actual cooperation performance as feedback, evaluation indicators, weights and algorithms shall be continuously calibrated and dynamically updated, so as to realize precise matching between multi-attribute decision-making methods and each subdivision of the new-material industry, and effectively boost the scientificity, pertinence and practical guiding value of partner-selection evaluation results.

4.2. Build a Full-process Conflict Management-and-Control Mechanism for Alliance Partner Selection Driven by Contract Governance and Digital Trust

Targeting the lack of conflict-response mechanisms for industrial-alliance partner selection, cutting-edge theoretical tools including evolutionary game theory, mechanism design and digital trust shall be introduced to construct a closed-loop full-process conflict management-and-control mechanism of “pre-event prevention - in-event management-and-control - post-event resolution”, shifting alliance governance from “passive response” to “whole-process governance”. In the early partner-selection stage, conflict adaptability shall be incorporated into evaluation dimensions. Candidate partners’ conflict compatibility shall be comprehensively assessed from perspectives including cooperation philosophy, interest demands, resource-input modes and corporate-culture compatibility. Priority shall be given to potential partners with high cooperation consensus and sound

conflict-coordination foundations. Meanwhile, evolutionary-game models shall be adopted to simulate and deduce the dynamic relationship between competition and cooperation within alliances, identifying stability conditions under different strategy combinations and predicting potential conflict points in key links such as benefit distribution, technology ownership and resource input in advance. In the intermediate partner-selection stage, complete cooperation contracts with clear rights, obligations and clauses shall be formulated together with intended partners, clarifying rights-and-obligation boundaries for core issues such as benefit distribution, technology ownership, resource input and achievement transformation. Cooperative-game benefit-allocation methods such as the Shapley value shall be referenced to build gradient benefit-distribution mechanisms reflecting contribution degrees and risk-sharing, balancing fairness and incentive effectiveness of distribution. Besides, blockchain smart-contract technology can be introduced to code-ize and program-execute key cooperation clauses. Leveraging the tamper-resistant and traceable features of distributed ledgers, performance transparency can be enhanced, risks of information asymmetry and opportunistic behaviors can be reduced, and a digital-trust foundation for alliance cooperation can be established. In the late partner-selection stage and the cooperation-operation phase, regular conflict monitoring, early-warning and consultation mechanisms shall be established. Handling paths for conflict escalation as well as arrangements for third-party mediation and arbitration shall be specified. Contract clauses and distribution schemes shall be revised dynamically in accordance with changes in cooperation stages, so as to resolve contradictions in resources, technologies, markets and other dimensions emerging in cooperation in a timely manner. Multiple measures shall be adopted to improve the stability and sustainability of alliance cooperation and amplify the overall benefits of complementary cooperative innovation.

4.3. Build a Market-integrated Cross-regional Partner-selection System Relying on the Unified National Large-scale Market

To address the problem of insufficient utilization of market integration in cross-regional partner selection, we shall keep pace with the cutting-edge progress of unified national large-scale market construction and factor-market-oriented allocation reform, better combine government coordination with market mechanisms, and fully release the creation effect of market integration. First, build cross-regional new-material-industry resource-complementarity databases and digital docking platforms. Core information including resource layouts, technical features and industrial policies of various regional new-material industries shall be systematically sorted out to construct regional-industrial “resource maps”. Big-data analysis and intelligent-matching algorithms shall be adopted to accurately identify inter-regional resource heterogeneity and complementary potential, resolving information-asymmetry difficulties in cross-regional partner selection. Second, promote cross-regional flow of innovation factors relying on unified factor markets. Keeping in line with the market-oriented allocation trend of factors including technology, talents, data and capital, we shall promote the universal redemption of science-and-technology innovation vouchers across regions, interconnection of technology-transaction information platforms, and safe and compliant circulation of scientific-research data, providing factor-level strong support for cross-regional complementary cooperation. Industrial-collaboration forms such as “R&D outside the region, transformation inside the region”, “enclave economy” and “joint-built parks” shall be explored to guide optimized combination of innovation factors and industrial resources on a larger scale. Third, formulate classified cross-regional partner-selection strategies. For different cooperation types such as resource-complementary, technology-complementary and market-complementary cooperation, differentiated candidate scopes, evaluation priorities and collaborative arrangements shall be matched. Priority shall be given to innovation entities with strong resource complementarity and sound regional-synergy foundations within

market-integration coordination systems. Meanwhile, government-coordination mechanisms including cross-regional policy coordination, benefit-sharing and tax-sharing, and cross-regional intellectual-property-right protection shall be improved to effectively counteract the diversion effect of market integration. The circulation and collaboration efficiency between cross-regional partners shall be guaranteed, inter-regional resource-complementarity advantages shall be fully unlocked, and the performance of cross-regional complementary cooperative innovation shall be practically improved.

4.4. Proactively Lay out Supporting Ecosystems for Complementary Partner Selection and Consolidate Institutional and Technical Foundations

Based on industrial-development trends and cutting-edge discipline progress, supporting systems for complementary partner selection shall be proactively laid out from dimensions including standards and norms, data factors, collaborative ecosystems and green-open orientation, providing institutional and technical guarantees for the implementation of the above-mentioned countermeasures. First, promote the construction of partner-selection standards and norms. Combined with characteristics of the new-material industry, evaluation standards and operational specifications for complementary partner selection shall be formulated. Third-party evaluation and certification service institutions shall be fostered to improve the standardization of partner-selection processes as well as the credibility and comparability of evaluation results. Second, consolidate foundations for data factors. Standardized governance and safe-and-compliant circulation of enterprise-innovation data, patent data, supply-chain data and other data shall be accelerated. On the premise of ensuring data security, sharing-and-utilization mechanisms of “data available but invisible” shall be explored to provide high-quality data support for intelligent partner selection and partners’ digital profiling. Third, construct a multi-agent collaborative partner-selection ecosystem. Relying on carriers such as innovation consortia and industrial technology-innovation alliances, in-depth collaboration among universities, research institutes, leading enterprises, small-and-medium-sized enterprises and new-type R&D institutions shall be promoted. A “government-industry-academic-R&D” collaborative partner-selection network shall be improved to facilitate efficient aggregation of knowledge, technologies, talents and other innovation resources in complementary cooperation. Fourth, deepen green-low-carbon and open-innovation orientation. Keeping up with the global green-low-carbon transformation trend, green and sustainability indicators shall be incorporated into partner-selection evaluation systems. While serving national high-level self-reliance and self-improvement in science and technology, international innovation cooperation and cross-border complementary partner selection shall be actively expanded to optimally allocate complementary resources worldwide and enhance the resilience and security level of industrial chains and supply chains. Fifth, strengthen talent and capital support. Mechanisms for flexible cross-regional mobility and joint training of high-level innovative talents shall be improved. Diversified capital including venture capital and industrial funds shall be guided to connect with complementary-cooperation projects, providing talent and capital guarantees for collaborative R&D and achievement transformation after partner selection, so as to drive the continuous evolution of complementary cooperative innovation partner-selection systems for new-material enterprises.

5. Conclusion

Selecting complementary cooperative innovation partners is of great significance for new-material enterprises to integrate innovation resources and support self-reliance and self-improvement in science and technology. At present, multi-dimensional evaluation frameworks have been established in this field, application scenarios keep expanding, and

relevant research is gradually adapted to the new-material industry. Nevertheless, prominent problems remain in practical practices: multi-attribute decision-making methods show insufficient adaptability to characteristics of the new-material industry, industrial alliances lack full-process conflict management-and-control mechanisms, and cross-regional partner selection fails to give full play to the efficiency of market integration.

Joint improvements are required from multiple aspects. We shall intelligently upgrade multi-attribute comprehensive evaluation methods, construct full-process conflict management-and-control mechanisms for alliances, improve cross-regional partner-selection systems in accordance with the unified national large-scale market, and build supporting ecosystems for partner selection. Multiple measures shall work together to promote the optimization and improvement of complementary cooperative innovation partner-selection systems for new-material enterprises.

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References

- [1] Wu, J., Xie, X. D., Sheng, Y. X., & Gui, L. (2024). Research on potential-partner selection of innovation consortia. *Complex Systems and Complexity Science*, 21(2), 104–111. <https://doi.org/10.13306/j.1672-3813.2024.02.013> (in Chinese)
- [2] Yang, T., Wang, Q. Y., Li, Y. L., & Su, J. F. (2025). Research on innovation-partner selection of traditional manufacturing enterprises from the resource-complementarity perspective. *Journal of Chongqing Technology and Business University (Social Sciences Edition)*, 42(4), 144–157. (in Chinese)
- [3] Li, J. C., Cheng, L., & Wu, M. Q. (2022). Government-coordinated market integration and firms' innovation-partner selection. *The Journal of World Economy*, 45(4), 187–216. (in Chinese)
- [4] Li, B. Z., & Yin, S. (2018). Research on multi-attribute decision-making model for manufacturing-enterprise partner selection from the perspective of cooperative innovation. *Operations Research and Management Science*, 27(6), 6–13. <https://doi.org/10.12005/orms.2018.0128> (in Chinese)
- [5] Wang, R. N. (2019). Research on characteristics and partner selection of industrial technology-innovation alliances. *Environmental Protection and Circular Economy*, 39(12), 79–82. (in Chinese)
- [6] Zhou, A. J., & Li, Y. (2019). A research review on partners under the background of open innovation. *Liaoning Economy*, (9), 24–25. (in Chinese)