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Research on the Transformation and Upgrading Path of Traditional Enterprises from the Perspective of Cross-Boundary Innovation

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Abstract

Cross-boundary innovation serves as a vital approach for traditional enterprises to break through development bottlenecks and realize transformation and upgrading amid a new round of scientific and technological revolution and industrial change. Set within the Chinese context, this paper first sorts out the theoretical connotation of cross-boundary innovation and systematically analyzes external environmental shifts and internal capability constraints confronting traditional enterprises in their transformation and upgrading. Further, it constructs a path framework for the cross-boundary transformation and upgrading of traditional enterprises from four dimensions: empowerment via technological cross-boundary innovation, transformation through service-oriented cross-boundary innovation, reconstruction enabled by platform-based cross-boundary innovation, and coordination driven by ecological cross-boundary innovation. This study reveals that cross-boundary innovation of traditional enterprises is not merely simple business diversification; instead, it represents a systematic reconstruction process anchored on core competencies, connected by digital technologies, and oriented toward value co-creation. On this basis, this paper proposes targeted strategic suggestions for traditional enterprises to implement cross-boundary innovation. The proposed framework enriches integrated research on traditional enterprises' transformation and upgrading. It also offers decision-making references for traditional enterprises with diverse resource endowments to advance cross-boundary innovation practices within China.

Keywords

Cross-boundary innovation, Traditional enterprises, Transformation and upgrading, Path research

1. Introduction

Traditional industries underpin China's real economy, contributing substantially to its GDP, tax revenue, and urban employment. They are the indispensable core carriers for building a modern industrial system and cultivating new quality productive forces. As a new round of scientific and technological revolution and industrial transformation is accelerating, the new generation of information technology is gradually integrating with traditional industries, and industrial boundaries are becoming increasingly blurred. Cross-boundary innovation has become the core driving force for advancing the high-end, intelligent and integrated transformation of traditional industries. China has successively issued a series of policy documents, such as the Action Plan for Further Deepening the Integrated Development of Advanced Manufacturing and Modern Service Industries (2024–2027) and the Action Plan for Promoting the Coordinated Development of Large, Medium, and Small Enterprises in the Platform Economy (2026–2028). These documents explicitly set out requirements to advance industrial integration, encourage cross-boundary collaborative innovation, and regard cross-boundary integration as the core lever to facilitate the high-end, intelligent and integrated transformation of traditional industries and deliver high-quality economic development. These policy signals indicate that cross-boundary integration has evolved from a voluntary choice of enterprises to an imperative for industrial development. In this context, traditional enterprises are facing unprecedented challenges and opportunities: on the one hand, the cross-boundary market incursion of digital native enterprises may erode the market space of traditional industries; on the other hand, cross-boundary innovation has opened a new avenue for traditional enterprises to break through industry boundaries and reshape competitive advantages. However, cross-boundary innovation in traditional enterprises is not achieved overnight. Constrained by path dependence, organizational inertia, and capability lock-in, many traditional enterprises have been caught in the dilemma of "inaction leads to obsolescence, while reckless cross-boundary moves risk failure" in the process of cross-boundary expansion. How to understand the underlying mechanism of cross-boundary innovation? What cross-boundary paths should traditional enterprises choose? These questions not only constitute important academic research topics, but also carry important practical implications.

This paper aims to systematically explore the path selection of transformation and upgrading of traditional enterprises from the perspective of cross-boundary innovation. Firstly, this paper sorts out the connotation and relevant theories of cross-boundary innovation. From the perspectives of external environmental drivers and internal competence constraints, it further analyzes the motivations and obstacles confronting the cross-boundary transformation of traditional enterprises in the Chinese context. On this basis, this study constructs a progressively-evolving four-dimensional path framework for transformation and upgrading, namely "empowerment through technological cross-boundary innovation, transformation via service-oriented cross-boundary innovation, reconstruction enabled by platform-based cross-boundary innovation, and synergy driven by ecological cross-boundary innovation", and clarifies the core logic and implementation priorities of each path. Finally, it proposes strategic suggestions for traditional enterprises to advance cross-boundary innovation.

2. Definition and Theoretical Explanation of Cross-Boundary Innovation

2.1 Definition of Cross-Boundary Innovation

Cross-boundary innovation refers to the process in which enterprises break through existing technological boundaries, organizational boundaries, and industrial boundaries, and create new products, new services, or new business models by integrating heterogeneous resources and capabilities to generate new value. This concept has undergone a theoretical evolution from "cross-boundary search" to "cross-boundary innovation" (Zhang & Ren, 2018). The theoretical origin of cross-boundary innovation can be traced back to research on boundary-spanning in Western organization theory. Early studies focused on the role of information interaction between organizations and the external environment, and argued that enterprises could compensate for the shortage of internal innovation resources by acquiring external information and resources through boundary-spanning behavior. With the rise of open innovation research, scholars further put forward the concept of "cross-boundary search", emphasizing that the search for and absorption of external heterogeneous knowledge constitutes the key path to improving innovation performance (Xiong et al., 2011). Since the beginning of the 21st century, the pervasive diffusion of digital technology has driven the continuous blurring of industrial boundaries. Cross-boundary practices have evolved from simple knowledge acquisition to multi-dimensional integration of technologies, businesses, and markets, and "cross-boundary innovation" has gradually become an independent research theme (Feng et al., 2023).

Enkel and Bader (2016) proposed that cross-boundary innovation of enterprises can break through geographical, industrial-technological, and organizational boundaries, and overcome the lock-in effect of inherent knowledge frameworks on corporate R&D paths based on an innovation paradigm characterized by the deep integration of diverse technologies. Zhang and Ren (2025) divided the enterprises' cross-boundary system into three dimensions: organizational cross-boundary, geographical cross-boundary, and technological cross-boundary. Based on the above research, the connotation of cross-boundary innovation can be understood from three dimensions: technological cross-boundary, industrial cross-boundary and organizational cross-boundary. First, technological cross-boundary refers to the practice whereby enterprises introduce emerging technologies originally belonging to different technology fields into their own business systems to realize cross-domain restructuring of technology elements (Wang & Huang, 2023). For example, traditional manufacturing enterprises introduce artificial intelligence, Internet of Things, big data and other technologies to promote the intelligent transformation of production processes. The essence of technological cross-boundary is to overcome the path dependence of technological paradigms and create new functional value through the integration of heterogeneous technologies. Second, industrial cross-boundary means that enterprises break through the original industrial boundaries, expand into unrelated or weakly related industrial fields, and realize the diversified restructuring of business portfolios (Enkel & Gassmann, 2010). Industrial cross-boundary can be a gradual extension of the industrial chain (such as forward integration or backward integration), or a leapfrogging industrial transition (such as shifting from traditional manufacturing to digital services).

The core of industrial cross-boundary is to identify the value intersection between different industries and realize value creation through capability transfer. Third, organizational cross-boundary means that enterprises break through traditional organizational boundaries and governance structures to build an open innovation network through cross-boundary mergers and acquisitions, strategic alliances, platform ecology and other mechanisms (Zhang & Ren, 2025). Organizational cross-boundary emphasizes the transformation from "closed innovation" to "open innovation". Enterprises no longer rely on internal resources to pursue innovation independently, but realize the integration of innovation resources and value co-creation through cross-organizational collaboration. These three dimensions are not independent of each other, but intertwined and sequentially progressive. Technological cross-boundary often serves as the fundamental underpinning for industrial cross-boundary, while organizational cross-boundary provides institutional support for technological and industrial cross-boundary practices.

2.2 Theoretical Explanation of Cross-Boundary Innovation

From a theoretical perspective, cross-boundary innovation can be explained from multiple perspectives. First, the Resource-Based View holds that the sustainable competitive advantage of enterprises stems from their heterogeneous, hard-to-imitate and non-substitutable combination of resources and capabilities (Barney, 1991). Traditional enterprises have accumulated a large number of physical and tacit resources during long-term operation, and these resources are prone to value saturation and efficiency bottlenecks within the original industrial boundaries. Cross-boundary innovation helps break the application boundaries of resources, enabling the creative recombination of core resources accumulated by traditional enterprises with heterogeneous resources such as externally introduced digital technologies and data factors of production, so that existing resources can unlock new value in new scenarios. Second, the Dynamic Capabilities Theory points out that in a rapidly changing environment, enterprises need dynamic capabilities of sensing opportunities, seizing resources and reconfiguring to continuously adapt to the environment and maintain competitive advantage (Teece, 2007). The transformation dilemma of traditional enterprises is essentially a dilemma of capability rigidity. Path dependence formed by long-term stable operation makes it difficult for traditional enterprises to perceive new opportunities for industrial innovation and lack the capability foundation to integrate heterogeneous resources. Cross-boundary innovation is precisely the concentrated embodiment of enterprises' dynamic capabilities: first, enterprises need to break through cognitive inertia and perceive opportunities brought by the blurring of industrial boundaries; second, they integrate key resources such as technology, talents and data through cross-boundary cooperation; finally, by reconstructing organizational structure, business processes and value creation patterns, enterprises complete the iterative upgrading of their own capability system. This theory explains the internal capability evolution mechanism for traditional enterprises to overcome organizational inertia and achieve transformation and upgrading. Third, Open Innovation Theory subverts the closed innovation paradigm of internal R&D in traditional enterprises. It proposes that enterprise innovation should balance two-way knowledge flow inside and outside the organization: allowing external R&D resources such as creative ideas and technologies to flow into the

enterprise for commercialization, and also allowing idle internal technologies, patents and production capacity to be exported externally to realize value monetization (Chesbrough, 2003). If traditional enterprises adopt a closed innovation mode for a long time and rely solely on internal teams to complete technological iteration, they are prone to problems such as homogeneous knowledge and low innovation efficiency. One of the core behaviors of cross-boundary innovation is to break organizational boundaries and carry out external collaboration: externally introducing heterogeneous knowledge from technology enterprises, universities and upstream and downstream partners of the industrial chain; internally opening up their own manufacturing resources, customer channels and test platforms to engage external entities in co-creation. Whether building industrial platforms, forming innovation consortia, or launching cross-boundary strategic alliances, the essence is the application of the open innovation mode in the context of cross-boundary transformation of traditional enterprises. Open Innovation Theory clearly demonstrates that organizational cross-boundary is an important organizational approach for traditional enterprises to address internal capability gaps, reduce cross-boundary innovation input costs, and share transformation trial-and-error risks (West & Bogers, 2014).

3. Drivers and Practical Dilemmas of Transformation and Upgrading of Traditional Enterprises

The drivers of transformation and upgrading faced by traditional enterprises first stems from profound changes in the external environment. From the technological dimension, the new generation of information technology, represented by artificial intelligence, big data, and cloud computing, is reshaping the operation logic of all industries. Digital technology is no longer merely a tool for improving efficiency, but a fundamental force driving changes in product forms, production methods and business models. As Shan et al. (2025) pointed out, "Industrial digitalization refers to the use of digital technologies and data factors of production to promote the transformation and upgrading of traditional industries, with a focus on the integration of digital technologies and the real economy." Such integration is not a simple superposition of technologies, but a systematic reconstruction of the value chain of traditional industries. From the competition dimension, the blurring of industrial boundaries has made the competitive landscape increasingly complex. Traditional enterprises face not only intra-industry competition, but also the challenge of cross-boundary market encroachment from other industries. At present, it is common for digital native enterprises to penetrate traditional industries by virtue of technological advantages and platform effects, which has intensified competition in traditional industries to a certain extent. Meanwhile, changes in customer demand are also forcing traditional enterprises to transform: consumers are no longer satisfied with standardized products, but pursue personalized and integrated solutions. From the policy dimension, the Chinese government has established a multi-dimensional policy system supporting cross-boundary innovation of traditional enterprises, from top-level design to specific actions. At the strategic level, the 15th Five-Year Plan clearly proposes to adhere to the direction of smart, green and integrated development, and lists the optimization and upgrading of traditional industries as the primary task of building a modern industrial system. The National Development and Reform Commission (NDRC)

emphasizes the need to promote the deep integration of scientific and technological innovation and industrial innovation, to inject sustained impetus into the optimization and upgrading of traditional industries. In terms of specific paths, seven departments including the Ministry of Industry and Information Technology (MIIT) jointly issued the Implementation Plan for Further Promoting the Innovative Development of Service-Oriented Manufacturing (2025–2028), which promotes the deep integration of advanced manufacturing and modern service industries, and guides manufacturing enterprises to deeply embed services into the full product life cycle. In addition, the Action Plan for Promoting the Coordinated Development of Large, Medium and Small-Sized Enterprises in the Platform Economy (2026–2028) was issued to systematically promote innovation synergy, ecological synergy and open synergy among enterprises of all sizes, effectively advancing the deep integration of the real economy and the digital economy. This series of policy arrangements has jointly built a favorable institutional environment and resource support for traditional enterprises to conduct cross-boundary innovation, thereby advancing the transformation and upgrading of traditional industries.

While external drivers are becoming increasingly prominent, traditional enterprises' pursuit of transformation through cross-boundary innovation still confronts various internal barriers. First, path dependence is the most fundamental obstacle. Traditional enterprises have formed stable technical routes, supplier networks and customer relationships during long-term operation. These systems are continuously solidified under the effect of self-reinforcing mechanisms, resulting in path dependence. If enterprises intend to break through original industrial boundaries, they need to bear not only economic costs such as equipment transformation and technology replacement, but also hidden costs such as the reconstruction of existing cooperative relationships and adjustment of organizational cognition (Liu & Wang, 2024). The existence of path dependence endows enterprises' development track with certain inertia; even when the external environment changes, enterprises tend to develop along the original path. Second, organizational inertia is the direct manifestation of path dependence at the enterprise organizational level, and also the primary visible obstacle to cross-boundary innovation. Enterprises operating in a specific industry for a long time will form a matching organizational structure, management processes and corporate culture. These "organizational genes" are a source of efficiency in a stable environment, but become shackles of transformation in a changing environment. Traditional enterprises often fall into the "success trap", where past successful experience becomes a cognitive barrier to identifying new opportunities and adopting new models. Third, the continuous effect of organizational inertia will further lead to capability lock-in of enterprises, constituting a capability barrier to cross-boundary transformation. Cross-boundary innovation requires enterprises to have cross-domain knowledge reserves, technical capabilities and management experience, while the capability system of traditional enterprises is often built around a single industrial logic. When they try to enter new technological or industrial fields, capability gaps will be exposed. Such capability gaps are reflected not only at the technical level, but also in non-technical capabilities such as market perception and ecosystem governance. Fourth, capability lock-in will further manifest itself as resource allocation conflicts,

becoming a direct resistance to cross-boundary transformation. Cross-boundary innovation requires sustained capital, talent and managerial attention, with a long payback period and high uncertainty. It is difficult for emerging cross-boundary businesses to quickly generate value contributions, and the tilt of resources toward them may encounter resistance from existing business departments, triggering conflicts in resource allocation between old and new businesses. Traditional enterprises may thus fall into a dilemma: excessive focus on existing businesses will miss the window of opportunity for cross-boundary transformation, while excessive investment in cross-boundary businesses may impact short-term operational stability. The contradiction in resource allocation has become a direct bottleneck restricting the implementation of cross-boundary innovation.

4. Path Analysis of Transformation and Upgrading of Traditional Enterprises Driven by Cross-Boundary Innovation

Existing studies have mostly separately examined the implementation effects of single modes such as digital upgrading, service-oriented extension and platform-based transformation, yet a complete transformation path framework with clear hierarchies and logical interconnections has not yet been established. Building on the foregoing definition of the three-dimensional connotation of cross-boundary innovation, as well as the analysis of external drivers and internal obstacles to the transformation of traditional enterprises, this paper constructs a four-tier progressive cross-boundary transformation path framework consisting of "technological cross-boundary innovation empowerment, service-oriented cross-boundary innovation transformation, platform-based cross-boundary innovation reconstruction, and ecological cross-boundary innovation synergy". The four paths evolve progressively from foundational to advanced levels and from internal to external scopes.

4.1 The Enabling Path of Technological Cross-Boundary Innovation: Restructuring Core Capabilities with Digital Technologies

Technological cross-boundary innovation serves as the starting point and fundamental support for cross-boundary innovation. Its core logic lies in introducing a new generation of digital technologies into the full processes of traditional businesses. Through the cross-domain integration and application of technological factors, enterprises restructure production modes, operational models and decision-making systems, thereby consolidating the capability foundation for subsequent cross-boundary initiatives in service, platform and ecosystem dimensions. Specifically, the enabling effect of technological cross-boundary innovation can be realized at three levels. At the production level, traditional manufacturing enterprises can achieve intelligent transformation of production processes by adopting the Industrial Internet, artificial intelligence, digital twins and other technologies. At the operational level, enterprises can optimize supply chain management, inventory management and quality management in a data-driven manner to boost operational efficiency and responsiveness. At the decision-making level, enterprises can leverage big data analytics and intelligent algorithms to enhance the rationality and accuracy of market forecasting, product development and strategic decision-making.

The key to technological cross-boundary innovation empowerment does not rest on the cutting-edge nature of technologies themselves, but on the fit between technologies and business scenarios. Traditional enterprises should not blindly pursue the "most advanced" technologies. Instead, they ought to select technical solutions that can effectively tackle business pain points and generate predictable value. In other words, technological cross-boundary innovation empowerment is mainly driven by business demands guiding technological adoption, rather than technological supply triggering business transformation. In terms of the scope of application, technological cross-boundary innovation empowerment acts as a universal entry path for the transformation of all types of traditional enterprises. It is especially suitable for small, medium and micro enterprises (SMMEs) with limited resources, which may start with single-point technology applications to address core business pain points.

4.2 The Transformation Path of Service-Oriented Cross-Boundary Innovation: Shifting from Product Providers to Solution Service Providers

Service-oriented cross-boundary innovation means that traditional manufacturing enterprises shift from a product-centered operational model to a service-oriented operational model centered on customer value. This path represents the direction of value upgrading enabled by technological cross-boundary innovation. Essentially, enterprises extend along the value chain toward high value-added links and achieve a value leap through the integrated model of "manufacturing + services". In the Opinions on Promoting the In-depth Integrated Development of Advanced Manufacturing and Modern Service Industries, the National Development and Reform Commission (NDRC) proposed multiple integrated approaches, including supporting the construction of smart factories, promoting flexible customization, developing shared production platforms, and strengthening full life-cycle management. With social development, the specific forms of service-oriented transformation have become increasingly diversified. Seven departments led by the Ministry of Industry and Information Technology (MIIT) systematically sorted out typical modes of service-oriented manufacturing in the Implementation Plan for Further Promoting the Innovative Development of Service-Oriented Manufacturing (2025–2028). These modes cover personalized customization, full life-cycle management, general integration and contracting, remote operation and maintenance, and integrated product-service provision.

The core logic of transformation driven by service-oriented cross-boundary innovation lies in the reconstruction of value propositions. The value proposition of traditional manufacturers is to "provide high-quality products", whereas after service-oriented transformation, enterprises aim to "deliver comprehensive solutions to address customer problems". This transformation requires traditional enterprises to shift their focus: from product functions to customer pain points, from completed transactions to full life-cycle value, and from internal operational efficiency to customer experience. It is worth noting that service-oriented cross-boundary innovation is not simply superimposing services onto products, but realizing the deep integration of products and services. Services are not mere add-ons to products, but an essential component of product value. Successful transformation via service-oriented cross-boundary innovation enables enterprises to build differentiated advantages amid product

homogenization competition and accomplish the transition from price competition to value competition.

4.3 The Restructuring Path of Platform-Based Cross-Boundary Innovation: Shifting from Value Chain Participants to Value Network Organizers

Platform-based cross-boundary innovation means that traditional enterprises transform from participants occupying a single link in the industrial chain to organizers or key nodes of value networks through constructing or embedding into platform ecosystems. This path represents an advanced stage of cross-boundary innovation: enterprises are no longer mere providers of products and services, but evolve into platform organizers that connect diverse participants and facilitate value co-creation. Platform-based cross-boundary innovation can be implemented in two directions. First, internal platform construction refers to a strategic process. Leveraging their positions in the industrial chain, traditional enterprises open up and establish structured connections between internal core resources (production data, supply chain channels, customer assets) and external diverse stakeholders (suppliers, developers, customers). This promotes their transition from a "linear value transmitter" to a "networked value coordinator". Second, external platform embedding means traditional enterprises actively integrate into existing platform ecosystems and achieve transformation and upgrading by relying on platforms' network effects and data capabilities (He et al., 2021). For most small and medium-sized traditional enterprises, embedding into existing platforms may be a more feasible option.

The critical success factor for the transformation path of platform-based cross-boundary innovation restructuring lies in thorough role transformation. Traditional enterprises are accustomed to "controlling" the value chain, while platformization requires firms to become enabling ecological participants. The shift from "control" to "empowerment" involves not only adjustments to business models, but also profound changes in organizational mindset (Van Alstyne et al., 2016).

4.4 The Synergy Path of Ecological Cross-Boundary Innovation: Shifting from Single-Point Breakthrough to Systematic Ecosystem Symbiosis

Ecological cross-boundary innovation represents the highest stage among the four paths, as well as the integration and advancement of the preceding three paths. Its core connotation is that traditional enterprises are no longer confined to single-point cross-boundary attempts. Instead, they achieve collaborative upgrading and value symbiosis with diverse stakeholders by constructing or participating in innovation ecosystems. The core characteristics of ecological cross-boundary innovation lie in three dimensions: stakeholder diversity, relational reciprocity, and dynamic evolution (Luo & Lin, 2015; Gao & Zhang, 2023). Stakeholder diversity means that the ecosystem encompasses various types of enterprises, institutions of varied attributes, and government bodies at different levels. Relational reciprocity indicates that ecological members are no longer locked in zero-sum competitive relationships, but form symbiotic ties built on complementary resources. Dynamic evolution means that the ecosystem is capable of self-renewal and self-adaptation, enabling continuous evolution alongside changes in the external environment.

China is vigorously promoting such ecological synergy at the national level. The Ministry of Industry

and Information Technology (MIIT), the National Development and Reform Commission (NDRC) and other authorities have successively issued action plans. These policies encourage leading enterprises to join industrial alliances and build shared pilot-scale testing and digital public platforms. They also foster integrated innovation ecosystems for large, medium, and small enterprises in a tiered manner and break down barriers to cross-industry cooperation through fiscal, tax, and financial support instruments. Relying on demonstration parks and innovation consortia, authorities then facilitate multi-dimensional coordination across technology, industry and organization, so as to systematically build a comprehensive cross-boundary innovation ecosystem. The "Mechanism for Establishing Innovative Joint Laboratories" proposed by Zhejiang Province embodies the same idea. It supports "technology-leading enterprises to build substantive joint laboratories together with universities, and leading firms to take the lead in forming industrial chain innovation consortia".

For traditional enterprises, ecological cross-boundary collaboration means breaking away from the innovation pattern of "working alone" and learning to identify their own roles and value within the ecological network. Enterprises are not required to possess core capabilities in every field, but they need to occupy an irreplaceable ecological niche within the ecosystem.

5. Conclusions, Implications, and Future Research

From the perspective of cross-boundary innovation, this paper explores the path selection for the transformation and upgrading of traditional enterprises and draws the following main conclusions. First, cross-boundary innovation is an inevitable strategic choice for traditional enterprises to cope with industrial changes and break through development bottlenecks. Against the backdrop of accelerating technological change, blurring industrial boundaries and reshaping competition landscape, traditional enterprises sticking to the original industrial logic will face mounting survival pressure. For them, cross-boundary innovation has become a necessity rather than an option. Second, traditional enterprises can adopt four progressive paths of cross-boundary innovation. Empowerment through technological cross-boundary innovation acts as the basic path to restructure core capabilities via digital technologies. Transformation via service-oriented cross-boundary innovation serves as the upgrading path to climb the value chain through "manufacturing + services". Restructuring enabled by platform-based cross-boundary innovation constitutes the organizational path for role transformation drawing on platform ecosystems. Synergy driven by ecological cross-boundary innovation represents the systematic path to achieve coordinated development through ecological symbiosis. These four paths are not mutually exclusive. Traditional enterprises can select appropriate path portfolios according to their own conditions and strategic objectives. Third, the essence of cross-boundary innovation lies in capability reconstruction instead of business diversification. Successful cross-boundary innovation does not mean simply "entering new industries". Instead, enterprises take core capabilities as the anchor and foster new competitive advantages through the creative recombination of heterogeneous resources.

Based on the above research conclusions, this paper proposes the following suggestions on the cross-

boundary innovation practices of traditional enterprises. First, conduct pre-diagnosis to identify cross-boundary directions. Before launching cross-boundary innovation, traditional enterprises shall systematically diagnose their core capabilities, resource endowments and competitive advantages, clarify "what they possess", "what they lack" and "what they pursue", and determine the directions and boundaries of cross-boundary activities accordingly. Cross-boundary innovation is not aimless expansion into various fields, but oriented extension of capabilities with clear goals. Second, take technology as a bridge to lower the threshold for cross-boundary innovation. The versatility of digital technologies enables them to serve as a "bridge" linking different industries. Traditional enterprises can regard digital transformation as a priority in cross-boundary innovation. By introducing digital technologies, enterprises can strengthen the infrastructure supporting cross-boundary innovation and reduce its organizational and cognitive costs. Third, adhere to gradual advancement and properly control the transformation pace. Cross-boundary innovation is a systematic project that cannot be accomplished overnight. Traditional enterprises should adopt the strategy of "piloting first followed by gradual rollout". They can verify the feasibility of cross-boundary models within controllable risk limits, accumulate relevant experience and capabilities, and then gradually expand the breadth and depth of cross-boundary innovation. Fourth, take openness as the core to foster cross-boundary ecosystems. Since the essence of cross-boundary innovation lies in breaking various boundaries, enterprises need to maintain an open organizational culture and establish matching organizational structures. Traditional enterprises should actively pursue cross-boundary cooperation with tech firms, platform enterprises and scientific research institutions. They shall promote cross-boundary innovation by leveraging external resources and joint collaboration, rather than relying solely on internal strengths.

This paper fails to carry out large-sample empirical tests for the relevant conclusions, so the external validity of the research findings needs further verification. Future research can be advanced along the following directions. First, construct a quantitative indicator system for cross-boundary innovation-driven transformation and upgrading, and verify the effectiveness and boundary conditions of various paths based on large-sample data analysis. Second, explore the heterogeneity among different types of traditional enterprises (e.g., large state-owned enterprises and small and medium-sized private enterprises, as well as manufacturing and service enterprises) in their choice of cross-boundary paths. Third, track the dynamic evolutionary process of traditional enterprises' cross-boundary innovation and reveal the key transition mechanisms from "cross-boundary attempts" to "cross-boundary success".

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