Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 25, No. 2, 2026

The Research on the Pathways Through Which Scenario Innovation Drives Firms' Breakthroughs in Key Core Technologies

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Abstract: With the accelerated development of a new round of technological revolution and industrial transformation, breakthroughs in key core technologies have become an important approach for firms to enhance innovation capabilities and build competitive advantages. However, the pursuit of key core technology breakthroughs is characterized by high technological complexity, long research and development cycles, and insufficient coordination of innovation resources, presenting significant challenges for firms. As an important mechanism connecting technological development with industrial demands, scenario innovation provides a new pathway for firms to overcome traditional innovation patterns and facilitate technological breakthroughs. Based on dynamic capability theory, this study employs literature review and normative analysis to explore the mechanism through which scenario innovation drives firms' breakthroughs in key core technologies and to identify corresponding implementation pathways. The findings indicate that scenario innovation can enhance firms' capabilities in key core technology breakthroughs by strengthening technology demand identification, facilitating innovation resource integration, optimizing R&D models, and establishing iterative feedback mechanisms. Accordingly, this study proposes several pathways, including enhancing scenario sensing capabilities, improving multi-agent collaborative innovation mechanisms, promoting the integration of technological R&D and application scenarios, and optimizing technology commercialization mechanisms. This study extends existing research on technological innovation mechanisms from the perspective of scenario innovation and provides theoretical insights and practical implications for firms seeking to enhance dynamic innovation capabilities and achieve breakthroughs in key core technologies.

Keywords: Key core technology breakthroughs; Dynamic capability theory; Innovation mechanism; Collaborative innovation.

1. Introduction

With the accelerated advancement of a new round of technological revolution and industrial transformation, key core technologies have become an essential foundation for firms to build competitive advantages and promote high-quality industrial development. However, breakthroughs in key core technologies are characterized by high R&D investment requirements, technological complexity, long innovation cycles, and significant uncertainty. Firms continue to face challenges such as insufficient identification of technological demands, fragmented innovation resources, inadequate collaboration among innovation actors, and misalignment between R&D outcomes and application needs. The traditional linear innovation model dominated by technology supply is increasingly unable to adapt to complex and dynamic innovation environments. Therefore, exploring new pathways for firms to achieve breakthroughs in key core technologies has become an important issue in the field of innovation management.

With the development of digital technologies and the continuous expansion of application scenarios, scenarios have gradually evolved from merely serving as carriers for technology application into important drivers of innovation activities. Yin et al. argue that scenario-driven innovation is not merely a process of applying technologies within specific contexts; rather, it involves integrating strategic objectives, technological capabilities, organizational resources, and market demands based on future-oriented visions and emerging needs, thereby overcoming technological bottlenecks and facilitating the development of new technologies and products (Yin et al., 2022). Therefore, scenario innovation can provide a new pathway for firms to achieve breakthroughs in key core technologies by enhancing demand identification and facilitating resource integration.

Furthermore, scenario innovation-driven breakthroughs in key core technologies do not merely involve technology deployment but rely on dynamic interactions among technological problem identification, multi-agent collaborative R&D, and scenario-based validation and feedback mechanisms. Yin et al. proposed a technology commercialization model based on scenario-driven innovation theory, emphasizing that innovation factors should be integrated around major scenario demands to enhance the alignment between technological supply and demand and promote continuous technological iteration (Yin et al., 2024). This provides a theoretical foundation for understanding how scenario innovation contributes to technological breakthroughs.

Existing studies have examined the mechanisms underlying firms' breakthroughs in key core technologies from perspectives such as digital innovation, data factor development, and collaborative innovation. Li et al. found that digital innovation contributes to firms' breakthroughs in critical core technologies, with knowledge absorption, knowledge integration capabilities, and industry–university–research collaboration serving as important mechanisms (Li et al., 2025). Guo et al. demonstrated that the market-oriented development of data factors facilitates critical core technology breakthroughs in advanced manufacturing

enterprises by alleviating financing constraints and reducing transaction costs(Guo et al., 2026). However, existing research has paid insufficient attention to how scenario demand identification, technological task formulation, resource coordination, and iterative validation jointly constitute a systematic pathway for key core technology breakthroughs.

Based on this research gap, this study adopts literature review and normative analysis methods and applies dynamic capability theory to investigate the mechanism through which scenario innovation drives firms' breakthroughs in key core technologies. Specifically, this study identifies practical barriers and proposes implementation pathways from five dimensions: scenario sensing, resource collaboration, technology–application integration, validation and feedback, and technology commercialization. The contributions of this study are threefold. First, it extends research on firms' key core technology breakthroughs from the perspective of scenario innovation. Second, it reveals the underlying mechanism through which scenario innovation facilitates technological breakthroughs. Third, it provides theoretical insights and practical implications for firms seeking to optimize their technology breakthrough strategies.

2. Literature Review and Theoretical Foundation

2.1. Scenario Innovation

With the development of digital technologies, innovation patterns have gradually shifted from traditional technology supply-driven approaches toward models driven by the integration of technologies, data, and application scenarios. Scenario innovation emphasizes value creation by embedding technologies into specific contexts based on real-world demands and practical problems. Yin et al. argued that scenario-driven digital and intelligent technology innovation breaks through the limitations of linear technological development by enabling continuous technological evolution driven by application scenarios (Yin et al., 2024). By leveraging the leading role of firms as innovation actors and the advantages of diverse application scenarios, it promotes the evolution of digital and intelligent technologies from imitation and replication, as well as internal diffusion, toward industrial expansion and original innovation leadership.

Furthermore, scenario innovation is not only a carrier for technology application but also an important driver of technological evolution. Ma and Wan proposed the "technology–data–scenario" innovation paradigm, suggesting that technological innovation, data-driven innovation, and scenario-driven innovation interact to form a positive feedback mechanism for innovation (Ma & Wan, 2025). Specifically, scenario-driven innovation enables the application of technologies and data in specific business contexts and, in turn, guides the direction of technological innovation. Jin et al. further found that manufacturing enterprises can transform application scenarios into drivers of technological breakthroughs through the pathway of "scenario-driven innovation–resource bricolage–technological innovation (Jin et al., 2025)." Therefore, scenario innovation provides an important foundation for firms to identify technological demands, integrate innovation resources, and promote breakthroughs in key core technologies.

2.2. Enterprise Breakthroughs in Critical Core Technologies

Key core technologies represent strategic technological resources that support industrial competitiveness and technological self-reliance. Their breakthroughs are characterized by high investment requirements, long development cycles, significant risks, and strong requirements for collaborative innovation. Existing studies suggest that breakthroughs in key core technologies depend not only on firms' internal R&D capabilities but also on multi-agent collaboration and innovation ecosystem support.

Sun et al. pointed out that breakthroughs in critical core technologies cannot be achieved by a single actor alone (Sun et al., 2024). Instead, they require the formation of systematic innovation capabilities through mechanisms such as resource integration, stakeholder collaboration, commercialization of innovation outcomes, and ecosystem coordination. As an important organizational mechanism for promoting industry–university–research collaboration, innovation consortia can strengthen firms' leading role in innovation activities, facilitate collaboration among diverse actors, and accelerate breakthroughs in key technological bottlenecks. Moreover, Guo et al. found that the market-oriented development of data factors enhances the technological innovation capabilities of advanced manufacturing enterprises by reducing information acquisition costs, promoting knowledge diffusion, and improving resource allocation efficiency, thereby facilitating breakthroughs in critical core technologies (Guo et al., 2026). Therefore, breakthroughs in key core technologies require not only internal capabilities of firms but also coordination among external scenarios, resources, and innovation networks.

2.3. Dynamic Capability Theory

Dynamic capability theory emphasizes that firms achieve sustained competitive advantages in complex and rapidly changing environments by sensing opportunities, integrating resources, and reconfiguring capabilities. Regarding breakthroughs in key core technologies, firms need not only technological R&D capabilities but also the ability to dynamically adjust innovation directions and resource allocation mechanisms in response to environmental changes.

In the digital environment, data and intelligent technologies can enhance firms' information processing capabilities and strategic adaptability. From the perspective of dynamic capabilities, Alghamdi and Agag found that big data analytics capabilities can improve firms' strategic agility and further enhance innovation performance (Alghamdi & Agag, 2023). Therefore, dynamic capability theory provides a theoretical explanation for how scenario innovation drives technological breakthroughs. Specifically, firms identify technological demands through scenario sensing, conduct collaborative R&D through resource integration, and achieve breakthroughs in key core technologies through capability reconfiguration.

2.4. Research Gap

In summary, existing studies have provided important foundations for understanding scenario innovation and breakthroughs in key core technologies; however, several research gaps remain. First, existing studies on scenario innovation have primarily focused on digital technology applications and industrial value creation, while providing

insufficient explanations regarding how scenarios further drive breakthroughs in key core technologies. Second, research on key core technologies has mainly emphasized innovation ecosystems, data factors, and collaborative mechanisms, with limited attention paid to how firms utilize specific scenarios to identify technological demands, allocate resources, and achieve capability reconfiguration. Third, although dynamic capability theory explains the process of capability renewal and development, limited research has systematically examined how scenario factors trigger the evolution of firms' dynamic capabilities. Therefore, based on dynamic capability theory, this study regards scenario innovation as a key driving factor and investigates how firms achieve breakthroughs in key core technologies through scenario identification, resource integration, and capability reconfiguration. This study aims to reveal the mechanism and implementation pathways through which scenario innovation facilitates technological breakthroughs.

3. Research Methods and Analytical Framework

3.1. Research Methods

This study adopts a conceptual research approach that combines literature review and normative analysis to explore the underlying mechanisms and implementation pathways through which scenario innovation drives enterprises' breakthroughs in critical core technologies. Given that breakthroughs in critical core technologies are characterized by long-term development processes, complexity, and systemic coordination, analyses based solely on variable relationships are insufficient to fully explain their formation mechanisms. Therefore, based on theories of scenario innovation, dynamic capabilities, and technology innovation management, this study examines the internal logic of how scenario innovation influences technological breakthroughs.

Specifically, this study first systematically reviews the existing literature on scenario innovation, critical core technology breakthroughs, and dynamic capability theory to identify the key influencing factors and mechanisms involved in enterprise technological breakthroughs. Second, considering the rapid development of digital technologies and the transformation of industrial innovation models, this study analyzes the challenges enterprises face during critical core technology development, including insufficient demand identification, difficulties in resource coordination, and inadequate capability adaptation. Finally, grounded in dynamic capability theory, this study develops an analytical framework of "scenario innovation–capability reconstruction–critical core technology breakthroughs" to further reveal the pathways through which scenario innovation facilitates technological breakthroughs.

3.2. Analytical Framework

This study follows the analytical logic of "scenario-driven innovation–capability reconstruction–technological breakthrough" to investigate the mechanisms through which scenario innovation affects enterprises' efforts to achieve breakthroughs in critical core technologies. Against the background of a new round of technological revolution and industrial transformation, enterprises face challenges including rapid technological iteration, increasingly complex market demands, and heightened uncertainty in innovation activities. Traditional technology supply-driven innovation models are insufficient to effectively address evolving industrial demands. Scenario innovation provides direction for technological breakthroughs by identifying problems and capturing demand feedback within real application contexts; however, transforming scenario-based demands into critical technological achievements still depends on enterprises' dynamic capabilities.

Based on this perspective, this study argues that scenario innovation promotes breakthroughs in critical core technologies through three main pathways. First, scenario identification facilitates the refinement of technological demands. By exploring practical problems and challenges embedded in application scenarios, enterprises can transform implicit needs into clearly defined technological objectives, thereby providing strategic direction for research and development activities. Second, scenario-based collaboration promotes the integration of innovation resources. Scenario innovation connects enterprises, research institutions, supply chain partners, and users, facilitating the coordinated allocation of knowledge, data, and technological resources and improving the efficiency of collaborative innovation and joint technological development. Third, scenario iteration enhances dynamic capabilities. Through continuous feedback from application processes, enterprises can optimize technological solutions, strengthen their capabilities in environmental sensing, resource integration, and organizational learning, and ultimately achieve sustained technological breakthroughs.

Ultimately, this study constructs the analytical framework of "scenario innovation–dynamic capabilities–critical core technology breakthroughs", emphasizing that scenario innovation is not only an important carrier for technology application but also a key driver for enterprises to identify innovation opportunities, integrate innovation resources, and develop technological breakthrough capabilities. Within this framework, scenarios provide the problem sources and application-driven motivation for technological breakthroughs; dynamic capabilities determine enterprises' ability to transform scenario opportunities into innovation outcomes; and critical core technology breakthroughs represent the value realization of enterprises' reconstructed innovation capabilities.

4. Mechanisms of Scenario Innovation-Driven Technology Breakthroughs

4.1. Scenario Sensing and Technology Demand Identification

Breakthroughs in critical core technologies are characterized by high complexity and uncertainty, and the primary challenge lies in accurately identifying the direction of technological advancement. Traditional technology innovation models often begin with firms' internal R&D capabilities, which may lead to a mismatch between technological supply and industrial demand. Scenario innovation places technologies within real application environments, enabling enterprises to identify key problems from industrial operations and users' actual needs, thereby improving their ability to perceive technological opportunities.

Yin et al. argued that scenario-driven digital and intelligent technology innovation breaks away from the linear development model of isolated technological advancement (Yin Ximing et al., 2024). By leveraging diverse application

scenarios, enterprises can promote technological innovation from imitation and replication toward original innovation leadership. Ma and Wan further proposed that the "technology–data–scenario" innovation paradigm can identify business bottlenecks and development demands through scenario-driven innovation, thereby guiding the direction of technological development (Ma Lei & Wan Jinbo, 2025). Therefore, scenario innovation not only provides an environment for technology application but also strengthens enterprises' ability to identify industrial trends, technological gaps, and innovation opportunities, providing clear objectives for critical core technology breakthroughs.

4.2. Scenario-Driven Innovation Model Reconstruction

Breakthroughs in critical core technologies cannot be achieved through isolated technological R&D activities alone; instead, they require enterprises to adapt their innovation models to complex and changing environments. Scenario innovation transforms the traditional one-way innovation path from technological development to market application, enabling enterprises to conduct R&D activities around specific application problems and achieve dynamic interaction between technological development and industrial demands.

Under a scenario-driven innovation model, enterprises no longer focus solely on technological advancement itself but pay greater attention to the compatibility between technologies and application environments. Through continuous feedback from scenarios, enterprises can adjust R&D directions and optimize innovation processes. Based on case studies of specialized and innovative manufacturing enterprises, Jin et al. found that scenario-driven innovation enables enterprises to establish a breakthrough pathway of "scenario-driven innovation–resource bricolage–technological innovation," allowing them to achieve technological innovation through dynamic resource adjustment (Jin Lei et al., 2025). Therefore, scenario innovation facilitates the transformation of traditional R&D models toward demand-oriented, rapid-iteration, and continuously optimized innovation models.

4.3. Scenario Collaboration and Resource Integration

Critical core technologies typically involve the integration of multidisciplinary knowledge and the construction of complex technological systems, making it difficult for individual enterprises to achieve breakthroughs independently. Therefore, integrating external innovation resources and promoting collaboration among multiple actors are essential conditions for technological breakthroughs.

Scenario innovation connects enterprises, universities, research institutions, and upstream and downstream industry partners through shared application objectives, forming collaborative innovation networks oriented toward solving specific problems. Sun et al. emphasized that breakthroughs in critical core technologies require mechanisms such as resource integration, multi-actor collaboration, achievement transformation, and ecosystem integration (Sun Bingmei et al., 2024). Innovation alliances serve as an important organizational model for promoting deep integration among industry, academia, and research. Furthermore, the flow and sharing of data elements can reduce information acquisition costs, facilitate knowledge diffusion, and optimize resource allocation, thereby providing support for enterprises' breakthroughs in critical core technologies. Thus, scenario innovation not only creates technological demands but also provides an organizational foundation for innovation resource coordination.

4.4. Scenario Feedback and Technology Iteration

Breakthroughs in critical core technologies are not achieved through a one-time process but gradually emerge through application verification, problem feedback, and continuous optimization. Scenario innovation provides enterprises with real application environments, allowing them to rapidly test technological effectiveness, identify technical deficiencies, and continuously adjust R&D solutions.

Ma and Wan argued that scenario-driven innovation can establish continuous feedback mechanisms among scenario innovation, technological innovation, and data-driven innovation, thereby promoting technological iteration and the expansion of application scenarios (Ma Lei & Wan Jinbo, 2025). Jin et al. also demonstrated that enterprises can continuously enhance their technological capabilities through resource adjustment and technological innovation activities during scenario-driven innovation processes (Jin Lei et al., 2025) . Therefore, the scenario feedback mechanism enables enterprises to establish continuous learning and capability renewal processes, transforming breakthroughs in critical core technologies from stage-based innovation into a process of continuous evolution.

5. Challenges of Scenario Innovation-Driven Technology Breakthroughs

5.1. Insufficient Scenario Sensing and Demand Misalignment

The core value of scenario innovation lies in identifying industrial challenges and technological demands through real application environments, thereby providing strategic direction for enterprises' critical core technology breakthroughs. However, some enterprises still conduct R&D activities primarily based on their existing technological capabilities, paying insufficient attention to potential demands embedded in application scenarios and changes in industrial trends. This results in a mismatch between technological development objectives and actual application needs. Yin et al. pointed out that scenario-driven innovation emphasizes identifying problems from specific contexts and using scenarios to guide technological innovation directions (Yin Ximing et al., 2022). However, enterprises currently face limitations in scenario exploration, demand identification, and value discovery. Consequently, enterprises may lack effective capabilities to perceive technological opportunities, affecting the accurate definition of critical core technology development objectives.

5.2. Limited Collaboration and Resource Integration

Breakthroughs in critical core technologies usually involve multidisciplinary knowledge integration and the construction of complex technological systems, making it difficult for individual enterprises to achieve sustained breakthroughs relying solely on internal resources. However, in practical innovation activities, problems such as incomplete

cooperation mechanisms and insufficient resource sharing among different innovation actors remain prevalent, resulting in fragmented R&D resources and reduced innovation efficiency. Sun et al. found that breakthroughs in critical core technologies require mechanisms including resource aggregation, multi-actor collaboration, achievement transformation, and ecosystem integration (Sun Bingmei et al., 2024). Innovation alliances can effectively promote deeper cooperation among enterprises, universities, and research institutions. Nevertheless, some enterprises have not yet established stable collaborative innovation networks, and the role of scenarios as a bridge connecting multiple innovation actors has not been fully realized.

5.3. R&D–Scenario Mismatch

Scenario innovation requires enterprises to achieve dynamic integration between technological development and real application environments. However, traditional R&D models often involve lengthy development cycles and insufficient application feedback, making it difficult for technological outcomes to adapt quickly to changing scenarios. Yin et al. argued that scenario-driven digital and intelligent technology innovation moves beyond the linear model of isolated technological development and requires continuous technological evolution through scenario-based applications (Yin Ximing et al., 2024). Nevertheless, some enterprises still regard scenarios merely as the final stage of technology application rather than an essential component of the innovation process. This disconnect between R&D activities and application demands constrains the efficiency of critical core technology breakthroughs.

5.4. Weak Scenario Validation and Feedback Mechanisms

Critical core technologies involve high levels of uncertainty and require continuous application validation for optimization and improvement. However, some enterprises lack systematic scenario testing platforms and feedback mechanisms, making it difficult to transfer problems identified during technological development back into the innovation process, thereby slowing technological iteration.

Ma and Wan proposed that the "technology–data–scenario" innovation paradigm can establish a positive feedback mechanism for innovation (Ma Lei & Wan Jinbo, 2025). Scenario applications not only facilitate technology deployment but also promote technological optimization and upgrading. Without effective feedback mechanisms, enterprises cannot fully leverage the role of scenarios in driving technological iteration.

5.5. Limited Commercialization and Scenario Diffusion

Achieving breakthroughs in critical core technologies requires not only successful technological development but also the diffusion of technological outcomes from individual application scenarios to broader industrial environments. However, some enterprises face challenges such as limited commercialization channels and insufficient application expansion capabilities, preventing the full realization of technological value.

Jin et al. found that specialized and innovative manufacturing enterprises achieve technological breakthroughs and industrial development through the pathway of "scenario-driven innovation–resource bricolage–technological innovation (Jin Lei et al., 2025)." However, scenario-driven innovation still requires further improvement in commercialization mechanisms. Therefore, promoting the cross-scenario replication and large-scale application of technological achievements remains a critical challenge for enterprises seeking to realize the value transformation of critical core technologies.

6. Pathways for Scenario Innovation-Driven Technology Breakthroughs

6.1. Scenario Sensing and Technology Direction Identification

The fundamental basis for scenario innovation-driven breakthroughs in critical core technologies is the ability of enterprises to identify real demands from complex application environments and transform them into clear technological development objectives. Currently, some enterprises still conduct R&D activities primarily based on their existing technological capabilities, which may result in a mismatch between technological innovation and industrial demands. Therefore, enterprises need to strengthen scenario sensing capabilities and utilize application scenarios as important sources for identifying technological opportunities and defining innovation tasks.

Specifically, enterprises should engage deeply with industrial practices and identify technological bottlenecks that constrain industrial development by analyzing key issues in manufacturing processes, user applications, and industrial chain collaboration. Based on these insights, enterprises can establish R&D directions with clear application value. Meanwhile, digital technologies should be leveraged to enhance dynamic sensing of market changes, technological trends, and industrial demands, improving the accuracy of critical core technology development and achieving effective alignment between technological innovation and industrial needs.

6.2. Multi-Actor Collaboration and Resource Integration

Breakthroughs in critical core technologies are highly complex and systemic processes, making it difficult for individual enterprises to achieve long-term technological advancement relying solely on their own resources. Therefore, enterprises need to establish multi-actor collaborative innovation mechanisms with application scenarios as the connecting foundation to achieve effective integration of innovation resources.

On the one hand, enterprises should strengthen their role as innovation leaders by enhancing cooperation with universities, research institutions, supply chain partners, and users. Through joint R&D, collaborative testing, and technology commercialization, different actors can achieve complementary advantages. On the other hand, enterprises should explore open innovation models such as innovation alliances and industrial consortiums to promote the coordinated flow of innovation elements, including knowledge, technology, talent, and data. By building stable innovation networks, enterprises can overcome resource constraints and improve the efficiency of critical core technology breakthroughs.

6.3. Technology–Scenario Integration

Breakthroughs in critical core technologies cannot be

achieved solely through laboratory-based research and development; instead, they require continuous optimization through practical application processes. Therefore, enterprises should promote the deep integration of technological development and application scenarios, embedding scenarios throughout the entire innovation process.

First, enterprises should move beyond the traditional linear innovation model of "R&D first, application later" and use real application environments as important references for technological development, allowing scenario demands to guide adjustments in R&D directions. Second, enterprises should strengthen the alignment between technological solutions and application environments by evaluating the effectiveness, reliability, and adaptability of technologies through practical operation. Through continuous interaction between scenarios and technologies, enterprises can enhance the application value of innovation outcomes and accelerate the transformation of critical core technologies from the R&D stage to industrial application.

6.4. Scenario Validation and Feedback Mechanisms

Breakthroughs in critical core technologies are characterized by long development cycles and high uncertainty, requiring continuous validation and optimization. Therefore, enterprises should establish effective scenario validation and feedback mechanisms, transforming application processes into important sources of technological improvement.

Enterprises can develop demonstration application scenarios and testing platforms to provide realistic operating environments for emerging technologies, while collecting application feedback in a timely manner to continuously adjust R&D strategies. Meanwhile, enterprises should strengthen data analysis and knowledge accumulation, transforming insights generated from scenario applications into organizational innovation capabilities and promoting continuous technological optimization and iterative upgrading.

6.5. Technology Commercialization and Diffusion

The ultimate goal of critical core technology development is to realize both technological and industrial value. Therefore, enterprises need to improve commercialization and diffusion mechanisms to facilitate the expansion of technological achievements from individual scenarios to broader application fields.

On the one hand, enterprises should strengthen the connection between technological outcomes and industrial demands by improving technology application efficiency through demonstration projects, industrial cooperation, and promotion platforms. On the other hand, enterprises should enhance the replicability of technological achievements by summarizing practical experiences across different application scenarios and promoting the expansion of mature technologies into related industries. Through improved commercialization mechanisms, enterprises can achieve effective transformation from technological breakthroughs to large-scale applications and further enhance industrial competitiveness.

In summary, scenario innovation-driven critical core technology breakthroughs represent a systematic process involving scenario identification, resource collaboration, technology integration, validation and iteration, and achievement diffusion. Enterprises need to use scenarios as the driving force, continuously enhance dynamic capabilities, transform external application opportunities into internal innovation capabilities, and achieve sustained breakthroughs in critical core technologies.

7. Discussion

7.1. Theoretical Implication

This study incorporates scenario innovation into the research framework of enterprise critical core technology breakthroughs, expanding existing perspectives on technological innovation research. Previous studies have primarily focused on the effects of technology supply, innovation resources, or external institutional environments on technological breakthroughs. In contrast, this study emphasizes the role of application scenarios in technological demand identification, resource collaboration, and capability reconstruction, further revealing how scenarios facilitate enterprises in achieving breakthroughs in critical core technologies. Meanwhile, based on dynamic capability theory, this study develops an analytical logic of "scenario innovation–capability evolution–technological breakthroughs", thereby extending the application of dynamic capability theory in complex technological innovation contexts.

7.2. Managerial Implications

The findings of this study suggest that enterprises pursuing breakthroughs in critical core technologies should not rely solely on internal R&D investment but should fully leverage the guiding role of application scenarios. Enterprises should enhance their scenario sensing capabilities to identify technological opportunities from industrial practices. Meanwhile, they should strengthen collaborative innovation with universities, research institutions, and industrial chain partners to establish open innovation systems for technological breakthroughs. In addition, enterprises should attach importance to the development of scenario validation and feedback mechanisms, promoting technological maturity through continuous iteration and achieving effective integration between technological breakthroughs and industrial applications.

7.3. Limitations and Future Research

This study primarily develops the mechanisms and implementation pathways through which scenario innovation drives enterprise critical core technology breakthroughs based on theoretical analysis, without conducting empirical validation using large-scale datasets. Future research could further examine these mechanisms through case studies, questionnaire surveys, or empirical analyses to verify the effects of different types of scenario innovation on technological breakthroughs. Furthermore, future studies may explore the boundary conditions and differentiated pathways of scenario innovation-driven critical core technology breakthroughs across various industries and types of enterprises.

8. Conclusion

Against the background of rapid digital technology development and intensified industrial competition,

breakthroughs in critical core technologies have become an important pathway for enterprises to enhance innovation capabilities and build competitive advantages. This study investigates how scenario innovation drives enterprise breakthroughs in critical core technologies. Based on dynamic capability theory, it analyzes the mechanisms through which scenario innovation facilitates technological breakthroughs and proposes corresponding implementation pathways.

The study finds that scenario innovation not only enables enterprises to accurately identify technological demands and innovation opportunities but also enhances their capabilities for critical core technology breakthroughs by promoting resource collaboration, facilitating R&D model reconstruction, and strengthening application feedback. Specifically, enterprises should strengthen scenario sensing capabilities, establish multi-actor collaborative innovation systems, promote the integration of technological development with application scenarios, and improve validation feedback and commercialization mechanisms, thereby achieving effective transformation from scenario value discovery to technological breakthroughs and industrial applications.

Overall, scenario innovation provides a critical driving force for enterprise breakthroughs in critical core technologies, while dynamic capabilities determine whether enterprises can transform scenario advantages into sustained innovation capabilities. Enterprises should adopt scenarios as the driving force, continuously enhance innovation resource integration and capability reconstruction, promote sustained breakthroughs in critical core technologies, and realize innovation-based value creation.

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