

Research on the Synergistic Development Path of Technological Innovation and Management in Manufacturing Enterprises within the Perspective of New-Quality Productive Forces

Chufeng Deng

*Business School, University of Shanghai for Science and Technology, Shanghai, China
cfdeng7@163.com*

Abstract: Amid the profound restructuring of the global economic landscape and the rapid advancement of the latest technological revolution, new-quality productive forces have emerged as a pivotal driver for manufacturing enterprises to overcome developmental bottlenecks and enhance their core competitiveness. This study conducts an in-depth analysis of the conceptual underpinnings and distinctive characteristics of new-quality productive forces, while systematically reviewing the evolutionary trajectories and theoretical foundations of both technological innovation and management science. By clarifying the intrinsic relationship and interactive mechanisms between technological innovation and management within the framework of new-quality productive forces, the research investigates the current state of technological innovation and managerial practices in manufacturing enterprises and identifies salient challenges hindering synergistic development. Furthermore, it proposes an integrated mechanism and actionable pathway for the deep integration of technological innovation and management tailored to modern manufacturing settings. The ultimate aim of this research is to provide a robust theoretical basis and practical guidance for manufacturing enterprises to achieve high-quality, sustainable development in the era of new-quality productive forces.

Keywords: Technological Innovation; Enterprise Management; New-Quality Productive Forces; Synergistic Pathways

1. Introduction

Against the backdrop of accelerated global economic integration and the ongoing, rapid advancement of the technological revolution—characterized by breakthroughs in artificial intelligence, green energy, and digitalization—the manufacturing sector, as a pivotal component of the real economy, exerts a profound influence on a nation's economic strength and international competitiveness. The emergence of the concept of “new-quality productive forces” opens a strategic gateway for manufacturing enterprises to transition into a new stage of high-end, intelligent, and sustainable development. It serves as a decisive instrument that enables firms to distinguish themselves in an increasingly fierce and dynamic global market. By emphasizing the birth of emerging industries and the transformation of traditional sectors through scientific and technological innovation, new-quality productive forces center on the efficient allocation and integration of innovative factors such as talent, knowledge, and capital. This integrated approach shapes new drivers and competitive advantages for industrial development, fostering an ecosystem where innovation leads productivity upgrades and structural optimization.

For manufacturing enterprises, technological innovation constitutes the fundamental driving force behind sustained growth and market leadership. It powers continuous product iteration and upgrades, transforms and optimizes process flows, and significantly boosts production efficiency. From the development and application of advanced materials to the deep integration of smart-manufacturing technologies—such as IoT, AI, and robotics—and from the adoption of fully digital production models to the implementation of innovative green and low-carbon technologies, technological innovation permeates every facet of a company's evolution. It not only creates differentiated competitive advantages but also unlocks new opportunities for market expansion and value creation. However, the successful execution of technological innovation does not take place in a vacuum. It relies critically on a supportive, agile, and well-aligned management system. Effective management provides the necessary foundation for innovation by enabling efficient resource integration, cross-functional coordination, strategic

alignment, and proactive risk control. It ensures that innovation initiatives are carried out systematically and sustainably, minimizing disruptions and maximizing impact. For example, strategic human resource management is essential to attract, develop, and retain high-caliber innovative talent, thereby supplying the intellectual capital required for R&D and breakthrough projects. Meticulous financial management ensures the rational allocation of innovation funds, improves investment efficiency, and supports sustained R&D spending. Meanwhile, robust supply-chain management guarantees the stable and timely availability of critical materials and components, preventing production halts and enabling seamless innovation scaling. Thus, the synergy between technological innovation and management is not merely beneficial—it is indispensable for manufacturing enterprises striving to excel in a complex and rapidly changing global landscape.

An in-depth investigation into the synergistic development pathway of technological innovation and management in manufacturing enterprises within the perspective of new-quality productive forces is of exceptional practical significance and theoretical value. At the practical level, it enables firms to precisely identify and overcome current technological bottlenecks and managerial dilemmas, thereby optimizing resource allocation and utilization efficiency, elevating economic performance and market competitiveness, and strengthening their voice and resilience within the global value chain. From a macroeconomic standpoint, manufacturing enterprises serve as a critical pillar of the national economy; improvements in their technological innovation and managerial capabilities can accelerate the entire sector's progression toward high-end, intelligent, and green transformation, foster industrial structure upgrading, and inject robust momentum into China's high-quality economic development. This, in turn, facilitates a fundamental shift in the mode of economic development and secures sustainable growth. Therefore, this study aims to comprehensively and systematically dissect the intrinsic nexus and synergistic mechanisms between technological innovation and management in manufacturing enterprises, and to explore feasible development strategies that provide solid theoretical grounding and actionable guidance for the thriving development of these enterprises in the era of new-quality productive forces.

2. Literature Review

New productive forces is a concept of great importance to China's high-quality development. Research on technological innovation and management in manufacturing enterprises from this perspective has a robust foundation internationally. Scholars like Teece et al. established the pivotal concept of "Dynamic Capabilities," arguing that a firm's sustained competitive advantage relies on its ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments, providing a core theoretical underpinning for the synergistic development of technological innovation and management in firms operating within complex ecosystems^[1]. Henderson and Clark further illuminated the nature of innovation within established organizations, demonstrating how management structures and knowledge processing patterns can significantly influence the success or failure of both incremental and radical technological innovation, offering critical insights for manufacturing firms navigating innovation pathways^[2]. Internationally, substantial empirical research exists. Studies analyzing manufacturing enterprises in Germany and Japan have yielded influential models such as the integration of Lean Management principles with Continuous Improvement (Kaizen) philosophies, showcasing how systemic management approaches can effectively support and drive sustained technological advancement, offering valuable blueprints for global manufacturers^[3].

Domestic research, aligned with the rapid evolution of China's manufacturing sector, has also seen significant depth in exploring new productive forces. While early foundational work exists, contemporary scholars like Chesbrough pioneered the concept of "Open Innovation," which has become central to understanding how firms can leverage both external and internal ideas and paths to market to accelerate internal innovation, highlighting the critical role of collaborative knowledge management and technology sourcing strategies – a principle highly relevant to Chinese manufacturing enterprises aiming for breakthroughs^[4]. Complementing this, Lee et al. provided extensive research on the "absorptive capacity" construct, detailing how firms develop routines and processes to acquire, assimilate, transform, and exploit external knowledge, which is fundamental to successfully managing and integrating novel technologies sourced both internally and externally^[5]. Empirical research on firm-level innovation consistently identifies key challenges faced in practice. Well-documented issues include strategic misalignment between R&D priorities and corporate goals, inefficient allocation of innovation resources, and organizational rigidities that hinder adaptation to new technological paradigms, underscoring the persistent need for refined organizational designs and governance structures to foster effective innovation-management synergy^[6]. Recent work, such as that by Gans, explores the integration of frontier technologies (e.g., AI, advanced robotics) into core manufacturing operations and the

concomitant management transformations required to capture value, offering fresh perspectives on the specific mechanisms of synergy in the context of intelligent manufacturing^[7]. Despite considerable progress, key gaps remain, particularly in understanding the nuanced mechanisms of synergistic coupling between technological innovation processes and specific management interventions, and in developing robust, quantifiable frameworks to assess the impact of such synergy on firm performance under the new productive forces paradigm. This constitutes a fertile area for future investigation.

3. Current Status and Problems of Technological Innovation and Management in Manufacturing Enterprises

3.1 Insufficient Linkage between Technological Innovation and Management

In many manufacturing enterprises, technological innovation and managerial activities often operate in silos, lacking effective integration and synergy. While R&D teams are dedicated to achieving cutting-edge technical breakthroughs, administrative departments tend to focus predominantly on daily operational routines. This structural and cultural divide results in poor communication, misaligned priorities, and inefficient collaboration across functions. Consequently, even promising innovations often fail to be seamlessly incorporated into production and management processes, thereby limiting their potential commercial impact.

For instance, after successfully developing a new technology, a company may discover that its management systems and operational frameworks are ill-prepared to adapt production schedules, optimize supply chain logistics, or roll out essential training programs in a timely and coherent manner. This kind of strategic and operational disconnect creates significant bottlenecks that not only hinder the effective dissemination and application of new technologies but also delay product launch cycles, generate redundant R&D expenditures, and reduce overall operational efficiency. Over time, such internal misalignment can accumulate into more severe consequences: it stifles the organization's agility, dampens employee morale and engagement in innovation initiatives, and weakens the company's ability to respond to market changes. Ultimately, these issues erode both the momentum of technological advancement and the organization's competitive standing in an increasingly fast-paced and innovation-driven market.

Therefore, breaking down departmental barriers and fostering deeper collaboration between R&D and management has become an imperative for manufacturing enterprises. Enhancing cross-functional integration is essential to boosting core competitiveness, accelerating innovation adoption, and achieving sustainable growth in an increasingly dynamic and demanding industrial landscape.

3.2 The pronounced imbalance between input and output in technological innovation constitutes a salient challenge

This imbalance manifests as a dual dilemma in which chronic underinvestment coexists with persistently low returns. On the input side, most manufacturing enterprises exhibit pronounced resource deficits in R&D. Financially, the ratio of R&D expenditure to total revenue remains conspicuously low, depriving firms of the capacity to undertake frontier technological projects. For instance, high-end equipment manufacturers frequently forgo the acquisition of mission-critical advanced machinery owing to capital constraints, thereby limiting improvements in product precision and quality. In human-capital terms, R&D teams are not only understaffed but also structurally skewed, with a marked scarcity of high-caliber talent. Deficiencies in talent cultivation and recruitment mechanisms further attenuate overall R&D capability, constraining the generation of high-quality innovations.

On the output side, even firms that maintain consistent investment in R&D often achieve disappointingly poor returns in terms of innovation efficiency. The innovations that result are frequently incremental and imitative in nature, lacking breakthroughs in core technologies or the development of proprietary intellectual property. This ultimately constrains the value-added potential of their products and undermines their competitive positioning. A clear illustration of this weakness can be seen in the electronics manufacturing sector, where many companies continue to depend heavily on imported key components and core technologies, leaving them vulnerable to supply chain disruptions and limiting their strategic autonomy. Moreover, the efficiency of commercializing these innovations remains critically low. There is a persistent disconnect between R&D activities and actual market demand, with many research projects proceeding without sufficient input from customers or alignment with broader industry trends. Compounding this issue, most firms lack effective internal mechanisms and integrated platform support

for technology transfer. Weak pilot-testing capabilities, immature scaling processes, and underdeveloped market channels further hamper the transformation of research outcomes into commercially viable products. As a result, a significant proportion of R&D outputs fail to transition into tangible economic benefits or enhance productive capacity, representing a substantial loss of resources and potential growth.

The interaction between insufficient input and inefficient output exacerbates the overall imbalance, severely undermining the innovative vitality and sustainable development potential of manufacturing enterprises.

3.3 Lagging Management Concepts and Systems Relative to Innovation Needs

In many manufacturing enterprises, outdated managerial concepts and institutional frameworks significantly hinder technological innovation and organizational adaptability. Conceptually, traditional management mindsets tend to overemphasize short-term production efficiency and cost reduction, while showing insufficient sensitivity to emerging technologies and shifting market dynamics. Strategic decisions are often based on past experience rather than data-driven insight, resulting in misalignment with actual market needs and missed opportunities for innovation.

Structurally, many manufacturing enterprises remain constrained by rigid hierarchical organizations and pronounced functional barriers that severely impede the fluid sharing of information and substantially slow down decision-making processes. The absence of cross-functional integration and collaborative mechanisms often leads to misalignment among R&D, production, and marketing departments. This disjointed operation makes it challenging to synchronize objectives and resources, thereby hindering the coherent and efficient advancement of innovation projects. For example, in new product development, such structural silos frequently result in significant delays, budget overruns, and products that fail to meet market expectations—largely due to fragmented workflows, duplicated efforts, and miscommunication between teams. These operational inefficiencies not only undermine project outcomes but also erode the organization's overall competitiveness and ability to respond agilely to market changes.

Furthermore, incentive mechanisms in such enterprises are frequently inadequate. There is often a weak link between employee compensation and innovation performance, and career advancement paths for technical talent remain unclear. These deficiencies not only dampen staff motivation and creativity but also contribute to high turnover among key innovators, further diminishing the organization's capacity for sustained innovation.

Together, these conceptual, structural, and motivational deficiencies fundamentally undermine the effectiveness of technological innovation and management systems. They constrain the enterprise's ability to evolve and compete effectively, particularly in the era of new-quality productive forces where agility, technology integration, and continuous innovation are crucial. Therefore, comprehensive and urgent reform is imperative to modernize management practices, foster cross-functional collaboration, and build a supportive environment for breakthrough innovation.

4. Synergistic Development Strategies for Technological Innovation and Management in Manufacturing Enterprises within the Perspective of New-Quality Productive Forces

4.1 Technological Innovation Strategy

Manufacturing enterprises should significantly increase their investment in technological innovation to secure sustainable long-term growth and strengthen their competitive advantage in an increasingly dynamic global market. Rather than relying exclusively on internal capital, companies ought to actively diversify their funding sources by strategically pursuing government grants and subsidies, engaging with venture capital investors interested in industrial innovation, and establishing cooperative partnerships with banks and other financial institutions. Moreover, creating dedicated R&D funds specifically aimed at forward-looking and foundational research is critical. Such targeted funding mechanisms will help bolster core innovation capabilities, facilitate early-stage technology exploration, and provide sustained financial support for high-risk, high-reward initiatives that might otherwise be overlooked. By adopting a more open and diversified approach to financing innovation, manufacturers can not only enhance their technological resilience but also accelerate the development and commercialization of breakthrough technologies.

Equally important is deepening industry–university–research collaboration. Enterprises should

establish long-term and stable partnerships with universities and research institutes, setting up joint R&D platforms that facilitate targeted technological breakthroughs. Such collaborations allow organizations to tackle concrete technical challenges more effectively while accelerating the transformation of academic achievements into commercial applications.

At the same time, technological innovation must be closely aligned with real-world market demand. Companies need to institute a comprehensive market research mechanism to continuously monitor evolving customer preferences and industry trends. By systematically integrating user feedback into the R&D process, firms can dynamically refine their innovation roadmaps and ensure that new technologies and products are closely tailored to market expectations. This market-driven approach not only enhances the relevance and competitiveness of innovative outputs but also significantly improves their commercial viability.

4.2 Management Innovation Strategy

Senior management must take the lead in transforming managerial mindsets by actively introducing and practicing modern concepts—such as innovation-driven governance, digital management, and agile management—and embedding them into corporate strategy and organizational values. Through internal training programs and open forums, firms should cultivate a culture that encourages experimentation and tolerates failure, thereby providing both ideological and cultural support for technological innovation.

Institutional optimization serves as the foundational enabler and linchpin of effective management innovation. To translate strategic vision into operational reality, enterprises should proactively restructure their organizations—shifting from rigid, hierarchical models toward more agile, flat, and networked configurations. This entails streamlining decision-making processes through clearer delegation, digital tools, and data-informed governance to reduce bottlenecks and enhance responsiveness. Additionally, it is critical to deliberately dismantle deep-rooted departmental silos and establish efficient, cross-functional collaboration mechanisms. These can include integrated workflows, shared performance metrics, and co-located project teams that align goals across R&D, production, marketing, and supply chain functions. Particular emphasis should be placed on promoting project-based matrix management structures, which enhance communication efficiency, improve resource allocation, and significantly accelerate end-to-end project execution. By embedding institutional flexibility and interdisciplinary cooperation into their core operating models, organizations can not only boost innovation outcomes but also build a sustainable culture of continuous improvement and adaptive change.

Talent management constitutes the core element. Firms must recruit and select personnel precisely aligned with job requirements, build systematic training and development pathways, and implement diversified incentive schemes that closely link compensation, benefits, and career advancement to individual performance and innovative contributions. Such measures will fully unleash employees' creative potential and commitment while securing a stable core talent pool.

4.3 Technological Innovation–Management Synergistic Mechanism

Manufacturing enterprises must establish a comprehensive and integrated synergy platform that leverages advanced information technologies—such as cloud computing, IoT, and big data analytics—to consolidate and unify data streams from R&D, production, sales, human resources, and other critical business systems. This platform should break down traditional information silos and create a centralized, real-time data ecosystem that enables seamless information sharing and cross-functional interaction across the organization. By applying advanced analytics, artificial intelligence, and machine learning to this unified data repository, enterprises can generate actionable insights that support informed technical decision-making—such as optimizing R&D directions and production processes—while also driving managerial optimization in areas like resource allocation, performance evaluation, and strategic planning. This data-driven approach enhances operational coherence, accelerates innovation cycles, and ultimately strengthens the enterprise's adaptability and competitiveness in a rapidly evolving market.

A normalized and well-structured cross-departmental communication and coordination mechanism is critical to breaking down organizational silos and enabling seamless integration of workflows. To achieve this, enterprises should implement periodic joint meetings that bring together key stakeholders from R&D, production, marketing, and supply chain to deliberate on project plans, resource allocation, and emergent challenges. Additionally, appointing designated liaison officers with clear mandates and accountability can help handle day-to-day coordination, resolve inter-departmental conflicts, and ensure continuous alignment of priorities. Furthermore, the deployment of integrated online collaboration

tools—such as enterprise social networks, project management platforms, and real-time document-sharing systems—facilitates seamless and instantaneous communication across teams and geographies. Together, these measures ensure that technological development and managerial efforts are tightly coupled, strategically aligned, and jointly advanced in support of the organization's broader innovation and business objectives.

To operationalize these measures, firms should institute a comprehensive performance-evaluation system covering dimensions such as the market value of technological innovations and the efficacy of project management. Evaluation outcomes must be explicitly linked to departmental performance metrics, team rewards, and individual incentives, thereby creating a robust incentive–constraint framework that propels the effective implementation of synergistic strategies and ultimately elevates the firm's core competitiveness and sustainable-development capacity.

5. Conclusions

This study provides a comprehensive and in-depth examination of the critical nexus between technological innovation and management within manufacturing enterprises, framed within the emerging paradigm of New-Quality Productive Forces (NQPF). It identifies a range of persistent challenges hindering synergistic development—including insufficient innovation investment, limited core technological capabilities, low conversion efficiency of R&D outcomes, outdated managerial philosophies, rigid institutional structures, and critical shortages in high-skilled talent. In response, the study proposes a series of integrated strategies designed to foster synergistic development between technical and managerial domains. Technological innovation and management are inherently mutually reinforcing; however, most enterprises remain constrained by these systemic deficiencies, underscoring the urgent need for holistic and structural reform.

To enhance technological innovation, firms must significantly increase R&D funding, actively expand collaborative networks with universities, research institutes, and industry partners, and strengthen market-oriented innovation mechanisms to ensure alignment with real-world demand. Management innovation, on the other hand, should be pursued through transformative shifts in philosophical approaches, institutional redesign, and modernized talent governance systems that incentivize creativity and cross-functional cooperation.

Furthermore, enterprises need to establish integrated innovation-management platforms, seamless cross-departmental communication mechanisms, and performance-based evaluation systems to institutionalize synergy and enhance organizational competitiveness.

Looking ahead, NQPF will play a central role in shaping the evolution of manufacturing enterprises. Companies must closely monitor emerging technological trends, increase investment in frontier fields such as digitalization and green manufacturing, and develop adaptive, agile management models. Simultaneously, they must strengthen their embeddedness within global value chains to elevate industrial positioning and value-creation capacity.

Concurrently, governments should refine policy instruments—including fiscal incentives, intellectual property protection, and industry-specific innovation funds—to support the manufacturing sector's transition toward high-end, intelligent, and green development. Such efforts will anchor high-quality economic growth and sustain the competitiveness and prosperity of manufacturing enterprises throughout ongoing global industrial transformation.

References

- [1] TEECE D J, PISANO G, SHUEN A. *Dynamic capabilities and strategic management*[J]. *Strategic Management Journal*, 1997, 18(7): 509-533.
- [2] HENDERSON R M, CLARK K B. *Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms*[J]. *Administrative Science Quarterly*, 1990, 35(1): 9.
- [3] KRIJNEN A. *The Toyota way: 14 management principles from the world's greatest manufacturer*[J]. *Action Learning Research and Practice*, 2007, 4(1): 109-111.
- [4] Mazzocchi S. *Open Innovation: The New Imperative for Creating and Profiting from Technology*[J]. *Innovation*, 2004, 6(3): 474.
- [5] COHEN W M, LEVINTHAL D A. *Absorptive Capacity: a new perspective on learning and innovation*[J]. *Administrative Science Quarterly*, 1990, 35(1): 128.

[6] TIDD J, BESSANT J. *Managing innovation: integrating technological, market and organizational change, Sixth edition*[M/OL]//Wiley eBooks. 2018.

[7] AGRAWAL A, GANS J, GOLDFARB A. *The Economics of Artificial Intelligence: An Agenda*[J]. NBER Books, 2019.