BUSINESS MODEL INNOVATION IN MANUFACTURING: FRAMEWORK AND KEY INFLUENCES

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ABSTRACT

Business model innovation (BMI) has emerged as a vital strategic response for manufacturing firms navigating the twin pressures of digital transformation and sustainability. While scholarly interest in BMI has grown significantly, the literature remains fragmented, often focusing on isolated drivers, mechanisms, or outcomes without a unifying framework. This study addresses the lack of conceptual integration by developing a comprehensive model—"Drivers–Innovation Paths–Impacts"—tailored to the manufacturing context. Guided by three research questions, it explores: (1) what internal and external factors jointly drive BMI; (2) through which innovation paths these drivers are enacted; and (3) what multidimensional impacts BMI generates at the firm and industry levels. The framework is derived from a thematic review of 90 influential studies published between 1957 and 2024. It identifies internal drivers such as resource endowments, dynamic capabilities, and managerial cognition, alongside external drivers including technological disruption, market dynamism, competitive pressure, and institutional regulation. Five core innovation paths are synthesized: element reconstruction, strategic transformation, value chain reconfiguration, innovation intensity management, and system integration. These paths connect strategic intent with implementation mechanisms. The outcomes of BMI are categorized into four dimensions: improved enterprise performance, sustainable competitive advantage, industry structure evolution, and progress toward green and digital development goals. This study contributes theoretically by integrating fragmented insights into a cohesive, multi-level conceptual model and introducing the "Drivers–Paths–Impacts" logic as an analytical lens for future empirical research. Practically, it offers a diagnostic and strategic tool for firms, policymakers, and ecosystem participants to assess transformation readiness and design targeted BMI strategies. While the framework was developed primarily from the perspective of China's manufacturing sector, it has broader relevance for industrial economies undergoing structural transformation.

Keywords: *Business Model Innovation, Conceptual Framework, Drivers, Innovation Paths, Manufacturing*

1. INTRODUCTION

In today's rapidly evolving manufacturing environment, Business Model Innovation (BMI) has emerged as a vital strategic lever for firms to maintain competitiveness and long-term viability. The convergence of digital technologies, intensified global competition, and complex regulatory environments has rendered traditional value creation and capture mechanisms increasingly inadequate to meet manufacturers' dual imperatives of efficiency and differentiation (World Manufacturing Forum, 2023).

Digital business models have enabled manufacturers not only to streamline internal operations but also to extend value delivery boundaries through servitization and customer co-creation. These new models offer enhanced resilience in the face of volatile markets, as demonstrated by recent empirical studies on digitalization-led transformation (Salfore et al., 2023).

Although a growing body of literature has addressed BMI's drivers, processes, and outcomes, most studies remain either descriptive or fragmented. Systematic reviews typically rely on bibliometric mapping, meta-analyses, or PRISMA-based synthesis but rarely construct integrated conceptual models tailored to the manufacturing sector (Kraus et al., 2020; Huang & Ichikohji, 2023). Similarly, empirical studies often focus on isolated variables—such as dynamic capabilities or environmental turbulence—without theoretically unifying how internal resources, managerial cognition, and external forces jointly shape innovation trajectories and performance outcomes (Witschel et al., 2022).

To address this gap, the present study adopts a conceptual modeling approach grounded in thematic literature selection. Based on 90 influential studies on manufacturing-oriented BMI, we develop a closed-loop "Drivers–Paths–Impacts" framework. Unlike systematic reviews that emphasize methodology, our objective is to provide a theory-driven structure that (1) fills conceptual gaps in BMI studies specific to manufacturing, (2) generates testable propositions for future empirical validation, and (3) supports practitioners with an integrative roadmap for diagnosing, designing, and implementing BMI strategies.

Accordingly, this study explores the following research questions:

- What internal and external factors—such as resources, managerial cognition, technological change, market dynamics, and institutional forces—jointly drive BMI in manufacturing firms?

- Through which innovation paths—such as element reconfiguration, strategic transformation, value chain reengineering, innovation intensity, and systems integration—are these drivers enacted?

- How does BMI affect firm-level performance, competitive advantage, industry structure, and sustainable development?

By addressing these questions, the paper contributes to a more nuanced understanding of how BMI unfolds in practice and offers a solid foundation for both scholarly investigation and managerial application. This perspective is also supported by prior research, which regards integrated BMI frameworks as key enablers of strategic adaptation in the face of digitalisation and sustainability imperatives (Foss & Saebi, 2017).

2. LITERATURE REVIEW: CONCEPTS, TYPES, AND CLASSIFICATION MAPPING

2.1 EVOLUTION OF THE BMI CONCEPT

Since the term "business model" was introduced by Bellman et al. (1957), its conceptual meaning has evolved from being vague and descriptive to more systematic and dynamic. Early scholars such as Chesbrough and Rosenbloom (2002) emphasized its role in transforming technology into economic value, while Amit and Zott (2001) defined it as a logic for value creation and capture. Teece (2010) later positioned business models as mechanisms enabling strategic adaptation to environmental changes.

With the growing prominence of digital transformation and sustainability concerns, Business Model Innovation (BMI) is now widely defined as the deliberate reconfiguration of a firm's value proposition, value delivery system, and revenue mechanisms to achieve competitiveness in turbulent environments (Foss & Saebi, 2018).

2.2 MAJOR TYPES OF BMI

The academic literature has identified multiple typologies of BMI. **Table 1** synthesizes nine dominant categories—strategic, systems, organizational, operational-process, internationalization, mechanism-design, value-delivery, element-reconfiguration, and dynamic innovation—each representing different foci and structural features. These typologies reflect how BMI occurs across strategic, structural, and process dimensions and provide a foundation for mapping innovation paths.

Table 1: Major BMI categories and definitions

Perspective	Key References	Definition Summary	Focus
Strategic Innovation	Hamel (1998); Malhotra (2000)	Redesign of strategy and value logic to disrupt industries and capture new opportunities	Strategic positioning
Systems Innovation	Voelpel et al. (2004); Sosna et al. (2010)	Systematic trial-and-error reconfiguration of value proposition, delivery, and capture mechanisms	Activity-system reconfiguration
Organizational Innovation	Bock et al. (2012)	Organizational-innovation form that combines new opportunity sets with structural adjustments	Structure & culture
Operational-Process Innovation	Johnson et al. (2008)	Changing core operational processes and resource configurations to meet customer needs	Process design
Internationalization	Rask (2014)	Business-model changes enabling international expansion and cross-border competition	Market entry modes
Mechanism Design	Hamel (2000); Osterwalder et al. (2005)	Redesign of value creation, delivery, and capture mechanisms to generate new commercial value	Revenue & incentive structures
Value-Delivery Innovation	Aspara et al. (2010); Cucculelli & Bettinelli (2015)	Transformation of value-creation and capture methods to adapt to technology and demand shifts	Co-creation, servitization
Element-Reconfiguration	George & Bock (2011); Casadesus-Masanell & Zhu (2013)	Recombination of core business-model elements (value proposition, activities, revenue) for competitive edge	Modular reconfiguration
Dynamic Innovation	Velu & Jacob (2016); Wirtz et al. (2016)	Continuous reengineering of value mechanisms under dynamic conditions for ongoing adaptation	Dynamic capabilities

2.3 MAPPING CLASSIFICATIONS TO THE CONCEPTUAL FRAMEWORK

Building on the classifications in **Table 1**, the present study integrates these nine BMI types into a unified conceptual logic by aligning them with the proposed "Drivers–Paths–Impacts" framework.

Specifically, factor-based innovations (George & Bock, 2011) and mechanism-based designs (Hamel, 2000) act as micro-level triggers by motivating reconfiguration of core business model elements. Strategic innovation (Hamel, 1998) and organizational innovation (Bock et al., 2012) provide macro-level strategic direction and structure for selecting appropriate innovation paths. Systemic innovation (Voelpel et al., 2004) is aligned with strategic transformation and factor reconfiguration paths, while dynamic innovation (Velu & Jacob, 2016) reflects firms' evolutionary mechanisms across disruption and adaptation.

Moreover, internationalization innovation (Rask, 2014) and operational-process innovation (Johnson et al., 2008) set the contextual boundaries for path implementation, ensuring alignment with global expansion and internal efficiency needs. Value-delivery innovation (Aspara et al., 2010; Cucculelli & Bettinelli, 2015) serves as a bridging mechanism, facilitating the transition across different innovation paths. This comprehensive mapping ensures terminological coherence and theoretical alignment between Table 1 and the Drivers–Paths–Impacts framework.

This mapping illustrates that the existing typologies are not mutually exclusive but functionally interconnected. By structurally aligning these categories with innovation drivers, implementation mechanisms, and outcome levels, the framework builds theoretical coherence and provides a systematic lens for investigating how and why different BMI forms emerge and evolve in manufacturing contexts.

2.4 THEORETICAL SUPPORT FOR THE RESEARCH QUESTIONS

While prior research offers abundant insights into specific BMI drivers, innovation practices, or performance outcomes, few studies have systematically explored their interrelationships within manufacturing. Existing models often emphasize either internal dynamic capabilities (Teece, 2010), digital innovation triggers (Nambisan, 2017), or specific outcomes like servitization (Sawhney et al., 2004), but rarely integrate these factors within a coherent theoretical logic.

This paper addresses the following research gaps identified in the literature:

- **On BMI drivers**: Most studies treat internal and external drivers in isolation, without explaining their interaction in shaping BMI decisions (Witschel et al., 2022; Zeng & Song, 2014).

- **On innovation paths**: While several BMI typologies exist, they lack empirical validation and are not clearly connected to firm-level strategy or capability theories (Velu & Jacob, 2016).

- **On outcomes**: Research has highlighted BMI's benefits but seldom categorizes impacts across performance, competitive, structural, and sustainability dimensions in a single framework (Salfore et al., 2023; Bocken & Ritala, 2022).

Therefore, by articulating the Drivers–Paths–Impacts model and connecting it to the above themes, this study offers a holistic conceptual approach that fills key theoretical gaps and enhances the empirical research agenda in manufacturing BMI.

3. LITERATURE SELECTION AND METHOD

3.1 SOURCES AND SCOPE

While systematic reviews have emphasized methodological rigor (Tranfield et al., 2003), this study adopts a conceptual modeling approach tailored for theoretical synthesis. A total of 90 core studies on Business Model Innovation (BMI) in manufacturing, published between 1957 and 2024, were selected based on thematic relevance, theoretical contribution, and contextual applicability. Sources include Google Scholar, Web of Science, ScienceDirect, CNKI, and authoritative industry reports such as the World Manufacturing Forum (2023).

The literature sample spans foundational conceptual work (e.g., Bellman et al., 1957), classical strategy and innovation theory (e.g., Amit & Zott, 2001; Teece, 2010), and recent advancements in digitalization, servitization, and sustainable innovation (e.g., Gazzola et al., 2024; Huang & Ichikohji, 2023). The selection emphasizes conceptual clarity, theoretical integration, and relevance to manufacturing contexts.

Priority was given to publications offering conceptual frameworks, theory-building contributions, and in-depth case-based insights. Systematic reviews, purely bibliometric analyses, or meta-analytical studies were excluded to maintain methodological consistency and focus on theoretical construction rather than empirical aggregation.

3.2 INCLUSION CRITERIA

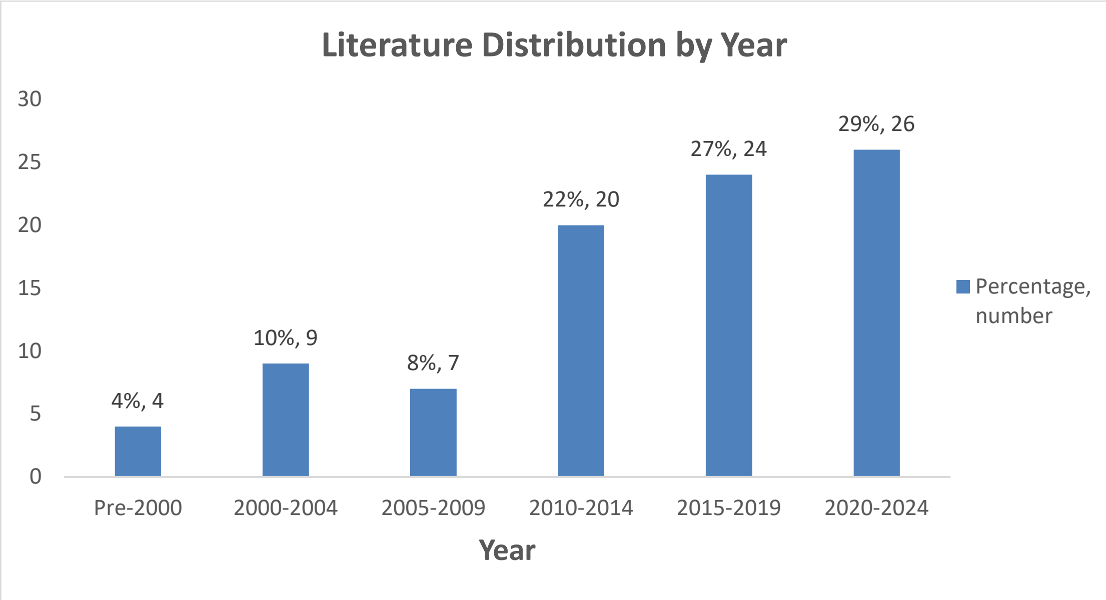
To ensure alignment with the "Drivers–Paths–Impacts" framework, literature was screened along three core dimensions:

- **Topical relevance**: Studies had to focus directly on BMI and either originate from manufacturing settings or offer transferable insights for manufacturing practices (e.g., Amit & Zott, 2001; Chesbrough, 2010).

- **Methodological contribution**: Priority was given to papers presenting conceptual models, theoretical frameworks, or multi-case exploratory designs that contribute to both theory building and framework validation (Demil & Lecocq, 2010). Purely descriptive or statistical reviews were excluded.

- **Source quality**: Only literature published in reputable SSCI/SCI (Q1/Q2) journals, academic monographs, or policy-level industry reports was considered to ensure rigor and academic credibility (Fink, 2019).

Figure 1. Annual distribution of literature



As shown in **Figure 1**, the selected studies are distributed across decades, with a sharp rise in contributions since 2010, reflecting BMI's growing significance in response to digital and green transformations. This temporal pattern reinforces the urgency of building integrated models for theory and practice.

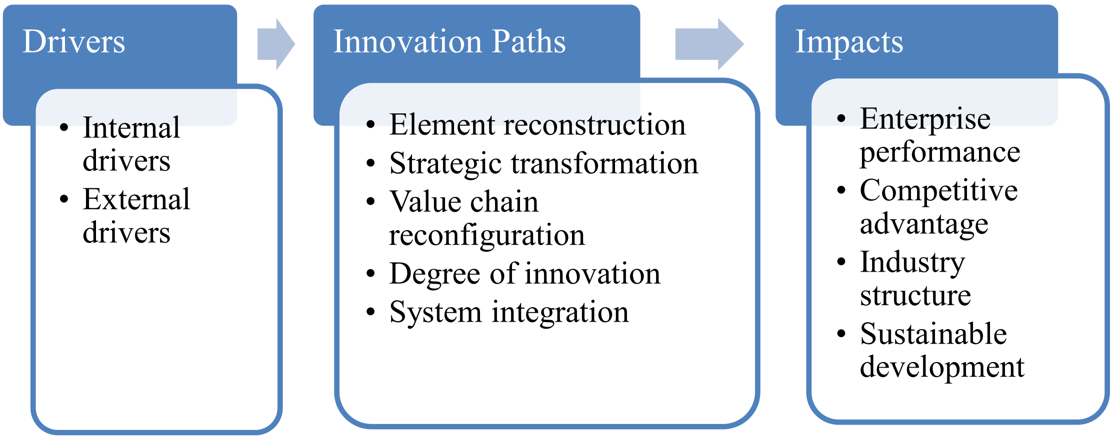
By applying this triple-gate selection logic, the final literature base offers a solid foundation for constructing and validating the proposed conceptual framework.

4. CONCEPTUAL FRAMEWORK

4.1 FRAMEWORK OVERVIEW

Drawing upon an extensive review of manufacturing-related BMI literature, this study develops a closed-loop conceptual framework titled "Drivers–Innovation Paths–Impacts" (see **Figure 2**). This framework integrates previously fragmented understandings of BMI drivers, mechanisms, and consequences in a unified structure, offering both theoretical coherence and practical applicability (Wu et al., 2015).

Figure 2. Framework for analysing business model innovation



At the **Drivers** level, BMI is initiated by a combination of internal and external forces. Internal drivers include resource endowments, dynamic capabilities, and managerial cognition, while external drivers encompass technological disruption and digitalization, market dynamism and customer needs, competitive pressure and ecosystem interactions, as well as the policy and institutional environment (Timmers, 1998; Wang et al., 2020; Huang & Ichikohji, 2023).

At the **Innovation Paths** level, manufacturers adopt strategic model innovation to reposition their role in the industry, conduct systemic element reconstruction and value chain reengineering for localized or networked change, and balance between incremental and disruptive innovations to cope with uncertainty. Additionally, internationalization strategies and operational adjustments define the boundary conditions, while value-based innovations serve as transitional bridges between paths (Zhang et al., 2021; Osterwalder & Pigneur, 2010).

At the **Impacts** level, BMI delivers multi-level outcomes including enhanced enterprise performance, sustainable competitive advantages, restructuring of industry structures, and contributions to green and digital transformation goals. For instance, efficiency-oriented and novelty-oriented innovations reduce costs and create new value, while ecosystem synergies reconstruct industrial order (Li & Qiao, 2019; Yang & Zhang, 2019).

This framework fills a gap in existing literature by offering a structured logic chain that links internal/external drivers with path-based BMI implementation and layered outcomes. It also provides a theoretical basis for future hypothesis development and empirical validation.

4.2 DRIVERS

4.2.1 INTERNAL DRIVERS

Resource Endowments & Dynamic Capabilities. Tangible resources such as capital and equipment, alongside intangible assets like patents, brands, and proprietary technologies, serve as foundations for business model reconfiguration (Demil & Lecocq, 2010). Dynamic capabilities—including learning, adaptation, and reorganization—are essential to convert these resources into system-level innovation. Mechanisms such as R&D-production-market feedback loops, executive learning cycles, and strategic alliances enhance agility and mitigate inertia (Huang & Ichikohji, 2023). Practices like resource bricolage and opportunity recognition further mediate how legacy operations absorb and scale new BMI modules (Guo et al., 2016).

Managerial Cognition & Vision. Top executives' cognitive frameworks and visionary leadership play a decisive role in shaping BMI trajectories. Mental models influence opportunity framing, strategic interpretation, and resource allocation (Martins et al., 2015; Sheehan & Stabell, 2007). Leadership commitment can accelerate international BMI deployment (Colovic, 2022), while interdisciplinary teams and entrepreneurial mindsets help firms respond rapidly to volatile environments (Shang & Jiang, 2021).

4.2.2 EXTERNAL DRIVERS

Technological Disruption & Digitalization. Both incremental and radical technological changes require firms to redesign core value components (Timmers, 1998). Digital technologies—such as IoT, AI, and 3D printing—enable a shift from product-centric models to platform-based service ecosystems (Nambisan, 2017; Rayna & Striukova, 2016; Zott & Amit, 2010). For example, XCMG's sensor-enabled O&M subscription platform evolved beyond equipment sales to condition-based services (Dong & Dai, 2023).

Market Dynamism & Customer Needs. Evolving consumer preferences and demand personalization drive iterative changes in business models (Johnson et al., 2008). Learning through experimentation and user co-creation are key mechanisms for adaptation (Habtay & Holmén, 2014; Sosna et al., 2010). Haier's "Human–Single–Integration" model exemplifies this by embedding real-time customer interaction into BMI design (Wang & Liu, 2016).

Competitive Pressure & Ecosystem Interactions. Intense market rivalry and growing complexity of supply networks push firms toward BMI to differentiate and respond flexibly (Casadesus-Masanell & Zhu, 2013; Velu & Jacob, 2016). Ecosystem actors—such as suppliers, governments, and tech partners—jointly shape BMI through collaboration and competition (Hansen et al., 2009; Shahri et al., 2023; Zeng & Song, 2014).

Policy & Institutional Environment. Regulatory changes and national strategic initiatives like "Made in China 2025" or carbon-neutrality commitments can constrain traditional models but also stimulate innovation toward sustainable, digital models (Bocken et al., 2014; Chi et al., 2022; Snihur & Zott, 2013).

4.3 INNOVATION PATHS

Based on the synthesis of 90 studies, this framework identifies five core BMI paths in manufacturing:

Element Reconstruction. Firms modify select business model components—value propositions, channels, or revenue logic—to initiate broader transformation. Modular tweaks often catalyze chain reactions throughout the system (Osterwalder & Pigneur, 2010; Demil & Lecocq, 2010; Taran et al., 2015). For instance, integrating sensor technology into machine tools led to a "pay-for-performance + subscription" model and downstream changes in distribution and service (Stanula et al., 2020).

Strategic Transformation. In times of environmental turbulence, firms reposition themselves strategically by altering revenue structures or assuming platform leadership. This allows them to target niche markets or orchestrate ecosystems (Chesbrough et al., 2013; Giesen et al., 2007; Holtström, 2022; Feng et al., 2008; Han & Zhang, 2022).

Value Chain Reconfiguration. This path draws on value chain logic (Porter, 1985) to optimize key activities—design, production, service—across organizational boundaries. Technologies such as digital twins enable real-time optimization and closed-loop feedback (Zhang et al., 2022; Wu et al., 2023).

Degree of Innovation. Firms balance incremental versus disruptive innovation in their BMI strategies. Incremental innovation enhances current models; disruptive moves redefine industry roles (Christensen, 1997; Osterwalder et al., 2005; Mezger, 2014).

System Integration. Firms embed themselves within broader innovation ecosystems, opening platforms to external developers and co-creating solutions with suppliers and users. This co-creation model leverages network effects and ecosystem governance (Adner, 2017; Ammirato et al., 2021; Downs & Velamuri, 2016).

4.4 IMPACTS

4.4.1 Impact on Enterprise Performance

BMI improves financial and operational performance by optimizing value delivery mechanisms. Hybrid models like “equipment + service” lead to revenue growth and profit stability (Bates et al., 2003; Brissaud et al., 2022; Sawhney et al., 2004). Examples include Hilti’s transformation into a “tool-as-a-service” provider (Johnson et al., 2008). Additionally, PLS-SEM analyses show that BMI significantly improves efficiency, thereby increasing financial returns (Salfore et al., 2023; Ministry of Industry and Information Technology of the People’s Republic of China, 2023).

4.4.2 Impact on Competitive Advantage

BMI generates sustainable competitive advantage through differentiation, adaptability, and ecosystem synergy (Bashir & Verma, 2017). For instance, SKF Brazil’s “Rotation-as-a-Service” model locks in customers and raises entry barriers (Chiarot et al., 2022). Siemens MindSphere’s platform expanded rapidly due to network effects and open APIs (Petrik & Herzwurm, 2019).

4.4.3 Impact on Industry Structure

BMI reshapes industry boundaries and value norms. Digital ecosystems increase entry barriers and restructure supply chain roles (Zhu & Iansiti, 2012; Li et al., 2022). In this context, business ecosystems are increasingly understood as modular architectures structured around activity linkages, which allows BMI to alter not only firm boundaries but also industry configurations (Jacobides et al., 2018).BMI-driven contractual innovations have also prompted regulators to revise technical standards (Hall et al., 2022; Jin et al., 2012).

4.4.4 Impact on Sustainable Development

BMI contributes to sustainability by integrating circular economy principles and environmental responsibility into business logic (Bocken et al., 2016; Bocken & Ritala, 2022). Cases like Rolls-Royce’s “Power by the Hour” show how BMI reduces resource use and enables green compliance. Initiatives like Sandvik’s recycling programs enhance social legitimacy and cluster-level green transformation (United Nations Global Compact, & KPMG International Cooperative, 2016; Ciulli et al., 2022).

5. DISCUSSION AND CONCLUSION

This paper developed a conceptual framework titled “Drivers–Paths–Impacts” to explore how business model innovation (BMI) emerges, unfolds, and delivers value within the manufacturing sector. Drawing from 90 scholarly sources and thematic mapping, the framework systematically links internal and external drivers, five core innovation paths, and four outcome layers. The following sections provide key reflections on theoretical alignment, practical implications, and the study’s broader relevance.

5.1 THEORETICAL AND MANAGERIAL IMPLICATIONS

The proposed framework advances BMI research by providing a holistic structure that bridges multiple fragmented streams in the literature. While prior studies have often focused on single drivers (e.g., dynamic capabilities, Teece, 2010) or isolated outcomes (e.g., servitization, Sawhney et al., 2004), this model unifies antecedents, mechanisms, and consequences within a cohesive logic. It highlights how internal resources and managerial cognition interact with external forces—including digitalization, policy pressure, and competitive dynamics—to trigger business model reconfiguration. This responds directly to the three research questions posed in the introduction and aligns with calls for integration in recent BMI scholarship (Foss & Saebi, 2017; Jacobides et al., 2018).

From a managerial perspective, the framework offers a diagnostic tool that enables firms to (1) assess their current BMI readiness based on internal and external conditions, (2) design appropriate innovation paths suited to strategic goals, and (3) anticipate multidimensional outcomes. Firms can apply the framework as a roadmap for strategic alignment and capability configuration during transformation initiatives.

5.2 CROSS-NATIONAL RELEVANCE

Although this study is based primarily on the Chinese manufacturing context, the framework’s structure and logic are applicable to other industrial economies undergoing digital and green transitions. Emerging markets can leverage the model to benchmark innovation paths against institutional conditions, while advanced economies may find it useful for managing legacy system transitions and ecosystem orchestration. Key drivers—such as regulatory reform, digital infrastructure, and customer customization—are increasingly global, making the findings relevant to broader comparative studies.

5.3 RESEARCH CONTRIBUTIONS

This study makes distinct contributions to both theory and practice in the domain of business model innovation in manufacturing.

From a theoretical perspective, the paper contributes in three main ways:

- It integrates previously scattered insights into a cohesive, multi-level conceptual model for understanding BMI in manufacturing contexts.
- It identifies and categorizes five distinct innovation paths, connecting micro-level managerial actions to macro-level outcomes such as performance and structural change.
- It introduces the "Drivers–Paths–Impacts" structure as a flexible analytical lens for guiding future empirical research and theoretical refinement.

From a practical standpoint, the paper offers valuable implications for managers and policymakers:

- It provides manufacturing firms with a structured diagnostic tool to assess transformation readiness and select appropriate innovation strategies.
- It offers ecosystem actors and regulators a framework for evaluating how institutional dynamics influence business model evolution.
- It helps decision-makers understand the multi-dimensional impacts of BMI—not only on firm performance but also on competitive advantage and industry-level dynamics.

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