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Resource Orchestration in Complex Ecosystems: A Framework for Business Model Dynamics in 5G IoT

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Abstract

This paper proposes an integrated conceptual framework combining the Resource-Based View (RBV), Dynamic Capabilities (DC), and Complex Adaptive Systems (CAS) to examine business model dynamics within the 5G Internet of Things (IoT) ecosystem. The convergence of 5G technology and IoT has driven rapid evolution, creating both opportunities and challenges for firms, and necessitating innovative approaches to strategic management. While RBV emphasizes resource-based advantages and DC focuses on adaptive capabilities in dynamic environments, these theories alone struggle to address the non-linear dynamics and emergent behaviors inherent in complex ecosystems like 5G IoT. To bridge this gap, the Ecosystem Dynamics Business Model (EDBM) framework integrates RBV, DC, and CAS, offering a multi-level perspective that links firm-specific strategies with ecosystem-level interactions. Applied to the 5G IoT context, the EDBM elucidates resource orchestration, adaptive mechanisms, and collaborative strategies critical for sustained competitive advantage. The paper contributes theoretically by extending RBV and DC to technology-driven, dynamic settings and practically by providing managers with tools to navigate ecosystem complexity. Additionally, it explores policy implications and suggests future research directions, including empirical validation and testing the framework’s broader applicability. This study underscores the importance of synthesizing established theories with CAS to address contemporary business challenges.

Keywords: 5G, IoT, business models, complex adaptive systems, dynamic capabilities ecosystem dynamics, resource-based view

1. Introduction

The convergence of fifth-generation (5G) wireless technology and the Internet of Things (IoT) is reshaping industries by enabling unprecedented levels of connectivity, data exchange, and automation (Akpakwu et al., 2017; Li et al., 2018). As 5G networks enhance communication with faster speeds, lower latency, and massive device connectivity, businesses face both opportunities and challenges in adapting to this dynamic ecosystem (Palattella et al., 2016). This paper integrates the Resource-Based View (RBV), Dynamic Capabilities (DC), and Complex Adaptive Systems (CAS) theories to propose a novel framework for understanding business model dynamics in the 5G IoT ecosystem, addressing the limitations of existing models and capturing the complexity of this transformative environment.

1.1 Background and Motivation

5G, with its advanced features such as ultra-reliable low-latency communication (URLLC), massive machine-type communications (mMTC), and enhanced mobile broadband (eMBB), provides the robust infrastructure needed to support the rapid proliferation of IoT devices (Li et al., 2018). IoT connects an expansive network of devices ranging from consumer gadgets like smart thermostats to industrial sensors in manufacturing enabling real-time data generation and processing. Projections estimate that by 2025, over 75 billion IoT devices will be active worldwide (Statista, 2023), with 5G acting as the critical enabler of this interconnected ecosystem.

This technological synergy has driven significant shifts in business model paradigms. Traditional product-centric models, where value is derived primarily from physical goods, are giving way to service-oriented and platform-based approaches (Iansiti & Levien, 2004). For example, telecommunications firms are transitioning from selling network access to offering integrated solutions like smart city platforms, where 5G-enabled IoT applications such as autonomous vehicles or real-time energy management create value through collaboration across multiple stakeholders. In the 5G IoT context, resource orchestration involves integrating tangible assets (e.g., network infrastructure) with intangible capabilities (e.g., data analytics) to meet dynamic market demands. Firms orchestrate resources not only internally but also through platform configurations that enable collaborative value creation in multi-stakeholder 5G ecosystems (Ahokangas et al., 2021).

Equally critical is the ecosystem complexity inherent in 5G IoT. Unlike linear value chains, these ecosystems comprise diverse actors such as network operators, device manufacturers, software providers, and end-users, whose interactions produce complex, adaptive behaviours (Holland, 1992). This complexity manifests in non-linear dynamics, where small innovations (e.g., a new IoT application) can trigger widespread industry shifts, and emergent properties, where novel business models arise unexpectedly from collective actions. Firms must navigate this intricate landscape to innovate and remain competitive. For instance, Ericsson’s deployment of 5G networks for smart manufacturing has enabled real-time IoT applications, such as predictive maintenance, reducing downtime by up to 30% for partnered firms (Ericsson, 2022). Conversely, Nokia’s 2021 annual report highlighted that competitors failing to integrate IoT ecosystems lost market share due to slower innovation cycles, underscoring the competitive necessity of ecosystem engagement (Nokia, 2021). Additionally, a 2023 industry analysis estimated that firms leveraging 5G IoT ecosystems could capture 25% higher revenue growth compared to those relying on standalone strategies (McKinsey & Company, 2023). The motivation for this research lies in the need to understand how firms can leverage 5G IoT opportunities amidst such complexity.

1.2 Research Gap and Justification

While the RBV and DC frameworks have long been used to explain firm performance, their standalone application reveals notable shortcomings in the 5G IoT ecosystem. RBV asserts that competitive advantage derives from possessing valuable, rare, inimitable, and non-substitutable (VRIN) resources (Barney, 1991). Although this perspective is valuable for identifying strategic assets like proprietary 5G patents, it adopts a static view that struggles to address the rapid technological evolution and resource obsolescence typical of 5G IoT (Eisenhardt & Martin, 2000). For instance, a firm's cutting-edge hardware may lose relevance as software-based solutions or competitor innovations redefine market standards.

DC offers a more adaptive lens, focusing on a firm's capacity to sense opportunities, seize them, and transform resources amid environmental changes (Teece et al., 1997). DC is particularly relevant in technology-driven contexts, illuminating how firms reconfigure capabilities to capitalize on 5G advancements (Teece, 2007). However, its firm-centric orientation limits its ability to fully capture the non-linear dynamics and emergent behaviours that define the 5G IoT ecosystem.

This gap underscores the need for CAS theory, which models systems as networks of interacting agents that adapt and evolve over time (Anderson, 1999; Holland, 1992). CAS excels at explaining the unpredictable feedback loops, self-organization, and emergent properties within the 5G IoT ecosystem. For example, the unexpected emergence of predictive maintenance models in manufacturing reflects how decentralized interactions among IoT devices and firms can reshape industry norms; optimized mMTC in 5G highlights CAS's role in transcending firm boundaries through emergent communications (Dash et al., 2022). Yet, CAS lacks the firm-specific focus of RBV and DC, suggesting that an integrated approach is necessary. Current research often applies these theories independently (e.g., Barney (1991, 1997), with limited efforts to combine them for analysing complex, technology-driven ecosystems like 5G IoT. This study seeks to bridge this gap by synthesizing RBV, DC, and CAS into a cohesive framework.

1.3 Research Objectives and Questions

This study aims to investigate the interplay between resources, capabilities, and ecosystem dynamics in driving business model innovation within the 5G IoT ecosystem. By integrating RBV, DC, and CAS, it seeks to construct a comprehensive theoretical framework that overcomes the limitations of each theory in isolation. The primary objective is to elucidate how firms leverage unique resources, adapt them dynamically, and respond to complex ecosystem interactions to innovate their business models in the 5G IoT context.

To steer this exploration, the study proposes the following research questions:

1) How do firm-specific resources (RBV) contribute to competitive advantage in the 5G IoT ecosystem, and what are the limitations of relying solely on resource possession in a dynamic context?

2) In what ways do DC enable firms to sense, seize, and transform resources to address technological disruptions and opportunities in 5G IoT?

3) How do CAS, such as non-linearity, self-organization, and emergence, shape the evolution of business models within the 5G IoT ecosystem?

4) What insights emerge from integrating RBV, DC, and CAS to understand the interplay between firm strategies and ecosystem dynamics in 5G IoT business model innovation?

These questions aim to dissect the multi-faceted dynamics of the 5G IoT ecosystem, offering both theoretical advancements and practical insights for firms navigating this transformative landscape.

2. Literature Review and Theoretical Foundations

2.1 Resource-Based View (RBV)

The RBV is a foundational theory in strategic management that attributes a firm's competitive advantage to its unique bundle of resources and capabilities (Barney, 1991; Wernerfelt, 1984). Resources can be tangible, such as physical infrastructure or financial capital, or intangible, such as intellectual property, brand equity, or organizational knowledge. According to Barney (1991), for resources to provide a sustainable competitive advantage, they must meet the VRIN criteria: they must be valuable (exploiting opportunities or neutralizing threats), rare (not widely possessed by competitors), inimitable (difficult to replicate), and non-substitutable (lacking viable alternatives).

In the context of the 5G ecosystem, RBV underscores the significance of distinctive resources that firms can leverage to differentiate themselves. For example, a telecommunications company with proprietary 5G technology patents or a robust network infrastructure can achieve a competitive edge by enabling low-latency, high-bandwidth IoT applications, such as smart manufacturing or autonomous vehicles. Similarly, strategic partnerships with IoT device manufacturers or software providers can enhance a firm's market position.

Despite its strengths, RBV has limitations in dynamic ecosystems like 5G IoT. Emerging 5G-IoT scenarios demand beyond static resources, incorporating trends like edge computing for adaptability (Shafique et al., 2020). In such environments, the value of resources can depreciate quickly, necessitating a more adaptive approach to maintain competitiveness. Thus, while RBV provides a critical starting point for understanding resource-based advantages, it falls short in capturing the fluidity of the 5G IoT landscape.

2.2 Dynamic Capabilities (DC)

DC extend the RBV by focusing on a firm's ability to adapt and innovate in response to rapid changing environments (Teece et al., 1997). Teece et al. (1997) define DC as "the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments." This framework comprises three core processes: sensing (identifying opportunities and threats), seizing (mobilizing resources to capitalize on opportunities), and transforming (reconfiguring the organization to sustain competitiveness) (Teece, 2007).

In the 5G IoT ecosystem, DC is particularly relevant due to the technological disruptions and opportunities presented by 5G's enhanced capabilities, such as URLLC and mMTC. For instance, a firm might sense the growing demand for real-time data processing, seize this opportunity by developing edge computing solutions integrated with 5G networks, and transform its business model to offer data-driven services. This adaptability enables firms to stay ahead in a sector characterized by continuous innovation and competition. DC empower firms to transform IoT resources amid 5G disruptions, fostering sustained advantage (Sullivan et al., 2023).

DC builds on RBV by introducing a dynamic dimension that addresses RBV's static limitations. While RBV focuses on possessing valuable resources, DC emphasizes the processes by which these resources are renewed and reconfigured, making it a vital lens for understanding firm performance in the volatile 5G IoT context.

2.3 Complex Adaptive Systems (CAS)

The CAS theory provides a framework for analysing systems composed of numerous interacting agents that adapt and evolve over time (Dooley, 1997). CAS is characterized by non-linearity (small changes can lead to disproportionate outcomes), self-organization (order emerges without central control), and emergence (system-level properties arise from agent interactions) (Anderson, 1999). Unlike traditional linear models, self-adaptive architectures exemplify CAS in IoT, where agents evolve through feedback in 5G-enabled systems (Alfonso et al., 2021).

The 5G IoT ecosystem exemplifies a CAS, with its multitude of interconnected components such as devices, networks, service providers, and end-users interacting dynamically. These interactions can lead to emergent phenomena, such as the spontaneous development of new business models (e.g., IoT-enabled smart cities) or innovative applications (e.g., autonomous drone networks), which cannot be fully anticipated from the behaviour of individual entities. For example, the integration of 5G's high-speed connectivity with IoT devices may foster self-organizing networks that optimize resource allocation in real time.

CAS theory complements RBV and DC by shifting the focus from the firm to the broader ecosystem. It offers insights into how collective adaptations and interactions among ecosystem actors drive innovation and resilience, making it a critical perspective for understanding the 5G IoT landscape.

2.4 Synthesis and Identified Gaps

The integration of RBV, DC, and CAS provides a robust theoretical lens for examining the 5G IoT ecosystem dynamics and their implications for business model innovation. RBV highlights the importance of unique, firm-specific resources as a source of competitive advantage (Barney, 1991). DC extends this by emphasizing the processes through which firms adapt these resources to dynamic conditions (Teece, 2007; Teece et al., 1997). Meanwhile, CAS broadens the perspective to the ecosystem level, capturing the emergent and adaptive behaviours arising from interactions among diverse agents (Anderson, 1999; Dooley, 1997).

This integrated approach is justified because it addresses multiple levels of analysis: the firm (RBV and DC) and the ecosystem (CAS). RBV identifies the foundational resources that firms can leverage, DC outlines how these resources are dynamically managed, and CAS explains how firm actions contribute to and are shaped by ecosystem-level dynamics. Together, these theories offer a holistic understanding of how firms can navigate the complexities of the 5G IoT ecosystem to develop sustainable business models.

However, the literature reveals several unresolved issues. First, there is a scarcity of empirical studies that operationalize and test the integration of RBV, DC, and CAS in the specific context of 5G IoT ecosystems. While individual theories such as Barney (1991); Teece et al. (1997); and Anderson (1999) have been widely applied, their combined application remains underexplored. Second, existing research often focuses on firm-level strategies without fully considering their interplay with ecosystem dynamics, limiting the understanding of how firm actions influence and are influenced by the broader system. This study aims to address these gaps by proposing a conceptual framework that integrates these perspectives, providing a foundation for future empirical investigations into 5G IoT business model innovation.

3. Conceptual Framework Development

This section develops a conceptual framework by integrating the RBV, DC, and CAS to provide a theoretical lens for understanding business models within the 5G IoT ecosystem. The framework, termed the Ecosystem Dynamics Business Model (EDBM), addresses the unique challenges of this rapidly evolving, interconnected environment.

3.1 Rationale for an Integrated Framework

The 5G IoT ecosystem's rapid technological advancements, high stakeholder interdependence, and emergent behaviours profoundly impact business model dynamics, necessitating adaptive and collaborative approaches. Rapid advancements, like edge computing, demand continuous innovation in value propositions, while interdependence among telecom operators, device makers, and developers shifts value creation to ecosystem-driven models, such as platforms. Emergent behaviours introduce uncertainty, requiring flexible models that leverage feedback for adaptation. These dynamics challenge traditional, firm-centric business models, highlighting the need for an integrated framework to navigate this complexity (Rong et al., 2015). Individually, RBV, DC, and CAS offer valuable perspectives, but their limitations necessitate an integrated approach to fully capture the dynamics of 5G IoT business models.

The RBV propose that firms achieve sustained competitive advantage through valuable, rare, inimitable, and non-substitutable (VRIN) resources (Barney, 1991). While RBV excels at identifying strategic resources such as 5G infrastructure or proprietary IoT platforms, it adopts a static perspective that overlooks how resources must evolve in response to technological disruptions and market shifts prevalent in the 5G IoT context (Wernerfelt, 1984). For instance, a firm's spectrum allocation may be a VRIN resource today but could lose relevance with new frequency allocations or competing technologies.

DC expand upon the RBV by focusing on a firm's capacity to integrate, develop, and adapt its resource base in response to evolving environmental conditions (Teece et al., 1997). DC is particularly relevant in the 5G IoT ecosystem, where firms must adapt to innovations like edge computing or shifting customer demands. However, DC focuses predominantly on firm-level processes and may not adequately address the broader ecosystem interactions, such as collaborations with device manufacturers or regulators that define IoT success (Eisenhardt & Martin, 2000).

CAS theory views ecosystems as networks of interacting agents that adapt and co-evolve, producing emergent outcomes (Holland, 1995). This perspective is apt for the 5G IoT ecosystem, where the actions of telecom operators, software providers, and end-users collectively shape market dynamics. The main ecosystem challenge in 5G is the demand of integrated frameworks to navigate interdependencies and innovate models (Magnaghi et al., 2025), but CAS lacks firm-specific strategic guidance, a concept that is limiting its applicability to individual business model development (Levin, 1998).

An integrated framework combining RBV, DC, and CAS overcomes these limitations. RBV provides the foundation by identifying critical resources and capabilities, DC adds mechanisms for adaptation and transformation, and CAS captures the systemic interactions and emergent behaviours within the ecosystem. This convergence is essential for 5G IoT business models, which require both internal strategic resilience and external adaptability to thrive in a complex, interconnected environment. Recent studies, such as Helfat and Peteraf (2015), support integrating DC with ecosystem perspectives, while Adner and Kapoor (2010) highlight the importance of understanding technological interdependencies, lending credence to a multi-theoretical approach.

Scholarly literature supports this multi-theoretical perspective. Helfat and Peteraf (2015) argue that integrating DC with ecosystem views enhances understanding of firm-environment co-evolution. Adner and Kapoor (2010) emphasize technological interdependencies in innovation ecosystems, advocating a broader lens that includes ecosystem dynamics. Teece (2018) further notes that in networked industries like IoT, firms must manage internal capabilities alongside their ecosystem roles. These insights underscore the need for a framework that synthesizes RBV's resource focus, DC's adaptive processes, and CAS's systemic perspective to address the 5G IoT ecosystem's complexity.

3.2 Proposed EDBM Framework

The rapid ecosystems evolution of 5G IoT demands business models that balance firm-specific resources, ecosystem adaptability, and continuous innovation. To address this, the EDBM framework is proposed, synthesizing the RBV, DC, and CAS (Holland, 2014). This tripartite model explains how firms leverage internal resources while adapting to emergent ecosystem dynamics, offering a novel lens for analysing 5G IoT business model innovation.

3.3 Macro Layer: Ecosystem Dynamics Through a CAS Lens

At the macro level, 5G IoT ecosystems are conceptualized as CAS, characterized by decentralized agents such as telecom operators, IoT developers, regulators, and end-users whose interactions generate nonlinear, emergent outcomes (Holland, 2014). Unlike static systems, CAS emphasize adaptation and co-evolution, where agents continuously learn from feedback loops, adjusting strategies to exploit opportunities or mitigate threats. For example, telecom operators may collaborate with smart city planners to deploy 5G-enabled traffic sensors, inadvertently spurring innovations like real-time congestion pricing models.

A critical feature of CAS in 5G IoT ecosystems is the role of feedback loops. Reinforcing loops amplify successful innovations, such as the proliferation of IoT devices following improvements in 5G network reliability while balancing loops impose constraints, such as data privacy regulations limiting unchecked data monetization (Purwanto et al., 2021). These dynamics create a fluid environment where firms must navigate uncertainty while capitalizing on serendipitous partnerships. For instance, the unexpected collaboration between automotive manufacturers and telecom providers in developing vehicle-to-everything (V2X) communication standards underscores the CAS principle of emergent behaviour (J. Li et al., 2019). Emergent outcomes in 5G IoT arise from integrated applications that foster self-organization among devices and stakeholders (Zreikat et al., 2025).

3.4 Meso Layer: Dynamic Resource Orchestration (RBV + DC + CAS)

The meso layer operationalizes the interplay between firm-level resources and ecosystem dynamics through DC, which enable firms to sense, seize, and transform opportunities in volatile environments (Teece, 2007). This layer addresses a key limitation of RBV which is its static focus on internal resources, by integrating CAS-driven adaptability and DC's renewal processes.

1) Sensing Ecosystem Shifts

The sensing phase involves detecting signals of change within the ecosystem, such as technological advancements (e.g., edge computing), regulatory updates (e.g., GDPR compliance for IoT data), or shifting consumer demands (e.g., real-time health monitoring). CAS principles explain how firms derive these signals through interactions with ecosystem agents. For example, a telecom operator might identify rising demand for ultra-low-latency 5G by engaging with industrial IoT partners in manufacturing (Eisenhardt & Martin, 2000).

2) Seizing Opportunities Through Resource Reconfiguration

In the seizing phase, firms mobilize VRIN resources (Barney, 1991) to exploit sensed opportunities. Crucially, seizing often involves resource bundling across ecosystem partners, for example, combining a telecom's 5G network slices with a startup's AI algorithms to create predictive maintenance solutions (Kulakli & Arikan, 2023). Also, cloud-edge hybrids allow firms to seize opportunities by optimizing scalable resources in 5G IoT, blending RBV assets with DC processes (Lilhore et al., 2025).

3) Transforming Capabilities for Sustained Relevance

The transforming phase ensures long-term alignment with ecosystem evolution. Firms update internal capabilities such as agile R&D teams or interoperable IoT platforms to remain competitive. For instance, a healthcare provider might transition from third-party AI analytics tools to in-house machine learning expertise, reducing dependency on external vendors (Teece, 2007). CAS co-evolution is evident here, as such transformations often spur reciprocal adaptations among partners, such as telecoms offering modular 5G APIs to accommodate diverse IoT use cases.

3.5 Micro Layer: Firm-Level Resources and Capabilities (RBV)

The micro layer anchors the framework in RBV's core tenet: sustainable competitive advantage stems from VRIN resources (Barney, 1991). In 5G IoT ecosystems, it span three categories:

1) Technological Resources: 5G infrastructure such as network slicing optimizes VRIN resources like 5G infrastructure, enabling firm-level advantages in IoT (Banchs et al., 2020). Other infrastructure examples are mmWave spectrum, interoperable IoT protocols, and AI/ML algorithms.

2) Organizational Resources: Data governance frameworks ensuring compliance with regulations like GDPR, and cross-industry partnership networks fostering co-innovation.

3) Human Resources: Teams skilled in agile development, ecosystem governance, and adaptive strategy.

In addition, the EDBM framework extends RBV by emphasizing resource fluidity, on how resources gain or lose value through ecosystem interactions.

3.6 Resource Fluidity

Resource fluidity is a core concept within the EDBM Framework, highlighting the dynamic nature of resources in the context of 5G IoT ecosystems. Unlike the traditional static view of resources as presented in the RBV, resource fluidity recognizes that the value of resources is not fixed but subject to change through interactions with the broader ecosystem. In essence, resource fluidity means that resources can appreciate or depreciate in value based on external influences. For example, a telecom's 5G spectrum (traditionally a VRIN resource) may depreciate if competitors adopt alternative technologies like satellite IoT, necessitating continuous capability renewal through DC (Kraaijenbrink et al., 2010). Conversely, if a firm's resources align with emerging ecosystem needs, their value can increase. Another example is AI algorithms enhance resource fluidity by enabling real-time reconfiguration in 5G network slicing, addressing obsolescence in IoT ecosystems (Dubey et al., 2025).

Firms must continuously manage and renew their resources to adapt to these changes. This involves sensing ecosystem shifts, seizing opportunities by reconfiguring resources, and transforming capabilities to remain competitive (Teece, 2007). Resource fluidity underscores the need for firms to be agile in their resource management, recognizing that the value of resources is fluid and subject to ecosystem dynamics. By embracing resource fluidity, firms can foster sustainable business model innovation, ensuring that their resources remain valuable and relevant in the ever-evolving landscape of 5G IoT ecosystems

3.7 Application to 5G IoT Ecosystem Dynamics

The EDBM is applied to the 5G IoT ecosystem, a complex network of telecom operators, device manufacturers, software developers, end-users, and regulators. This ecosystem is defined by rapid technological evolution, interdependence, and emerging business models, making the integrated framework particularly relevant.

1) Resource and Capability Base:

Firms require 5G infrastructure (e.g., base stations, spectrum), IoT platforms, and cybersecurity measures as core resources. Capabilities include network orchestration, data analytics, and innovation in application development (e.g., smart cities or industrial IoT). These align with RBV’s emphasis on leveraging strategic assets for competitive advantage.

2) Adaptive Mechanisms:

To remain competitive, firms must adapt to technological shifts, such as the transition to 6G or the integration of artificial intelligence in IoT. This involves R&D investments, partnerships with tech providers, and agile responses to regulatory changes (Teece et al., 1997). For example, a telecom operator might collaborate with an edge computing provider to enhance IoT service delivery.

3) Ecosystem Interactions:

Success in 5G IoT depends on collaboration and competition. A smart home solution might require device makers, network providers, and app developers to align standards and share data, while firms compete for market dominance (Rong et al., 2015). CAS highlights how these interactions drive ecosystem evolution, such as the emergence of new value propositions like subscription-based IoT services.

4) Feedback and Learning Loops:

Firms use real-time data from IoT deployments (e.g., user behaviour, network performance) to refine offerings and strategies. For instance, feedback from early 5G IoT pilots can inform infrastructure upgrades or service enhancements, fostering resilience and innovation (Westerlund et al., 2014). This application demonstrates how the EDBM enables firms to balance internal strategic priorities with external ecosystem dynamics, addressing the complexity of 5G IoT business models.

3.8 Diagrammatic Representation

The EDBM is visually represented in Figure 1, a conceptual model illustrating the integration of RBV, DC, and CAS. It visually captures the three layers of the EDBM framework and their interactions, providing a holistic view of how firms can adapt and innovate within 5G

IoT ecosystems.

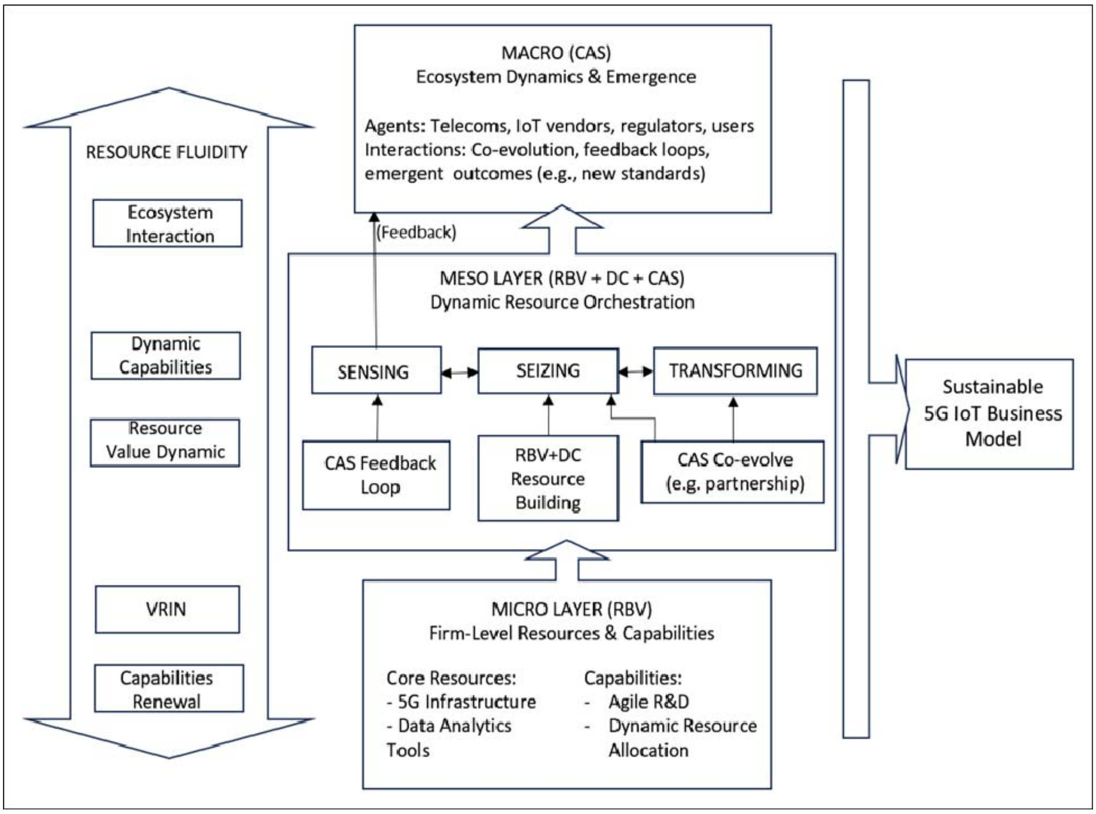

Figure 1. Conceptual framework of the Ecosystem Dynamics Business Model (EDBM)

The interaction between these layers is cyclical and dynamic:

a) From Macro to Meso: The Macro Layer provides the signals of change that firms must sense. These signals come from the interactions and feedback loops within the ecosystem, influencing the strategies and capabilities that firms develop at the Meso Level.

b) From Meso to Micro: The Meso Layer's actions, such as seizing opportunities through resource reconfiguration, directly impact the management and value of firm-level resources at the Micro Level. Here, firms adapt their resources to align with ecosystem needs.

c) From Micro to Macro: The outcomes of resource management and capability renewal at the Micro Level can influence the broader ecosystem dynamics. For instance, a firm's innovation in IoT protocols might spur new standards or regulations at the Macro Level, creating a feedback loop.

d) From Macro to Micro: The Macro Layer's dynamics can also directly impact firm-level resources, as seen in the example of resource fluidity. Changes in technology or regulations can alter the value of a firm's resources, necessitating continuous adaptation.

In summary, the EDBM framework provides a comprehensive approach to business model innovation in 5G IoT ecosystems by integrating the RBV, DC, and CAS. At the macro level, it conceptualizes these ecosystems as CAS, highlighting the importance of feedback loops and emergent behavior. The Meso Layer operationalizes the interplay between firm-level resources and ecosystem dynamics through DC, enabling firms to sense, seize, and transform opportunities. The micro layer focuses on firm-specific VRIN resources, emphasizing resource fluidity, how these resources gain or lose value through ecosystem interactions. The EDBM framework extends traditional RBV by incorporating the dynamic nature of resources and capabilities, offering a novel lens for firms to navigate the complexities of 5G IoT ecosystems while fostering continuous innovation and adaptability.

4. Discussions

The EDBM framework integrates the RBV, DC, and CAS to provide a theoretical lens for understanding business model dynamics in the 5G IoT ecosystem. This section explores the framework's theoretical contributions, managerial insights, policy implications, and limitations, offering a comprehensive discussion of its significance and potential for future development.

4.1 Theoretical Implications

The EDBM framework extends existing strategic management theories by synthesizing RBV, DC, and CAS into a unified model that captures the complexities of the 5G IoT ecosystem. This integration not only enhances the explanatory power of each theory but also provides a novel perspective on business model evolution in dynamic, technology-driven contexts.

RBV states that competitive advantage stems from valuable, rare, inimitable, and non-substitutable resources (Barney, 1991). However, its static focus limits its applicability in fast-evolving ecosystems like 5G IoT, where resource value can shift rapidly due to technological advancements (Priem & Butler, 2001). The EDBM addresses this by incorporating dynamic elements, suggesting that resources must be continually reconfigured to remain relevant. This builds on DC theory, which emphasizes a firm's ability to sense, seize, and transform opportunities through adaptive capabilities (Teece et al., 1997). The EDBM extends DC by situating these capabilities within an ecosystem context, recognizing that firm-level adaptation influences and is influenced by broader system dynamics (Schilke et al., 2018).

The inclusion of CAS further enriches the framework by introducing concepts of emergence and co-evolution (Holland, 1995). In the 5G IoT ecosystem, small changes such as a new standard or partnership can lead to significant, unpredictable shifts across the network. The EDBM's feedback loops illustrate how firms and ecosystems co-evolve, offering a systemic perspective absent from traditional RBV and DC models (Levin, 1998). This synthesis provides a multi-level lens that bridges firm-specific strategies with ecosystem-level phenomena, responding to calls for integrative approaches in strategic management (Adner & Kapoor, 2010).

By applying this framework to 5G IoT, the EDBM offers a novel perspective on business model evolution, highlighting how firms navigate technological disruption and interdependence to create and capture value. This contribution advances theoretical discussions on ecosystem dynamics and strategic adaptation in networked industries (Teece, 2018).

4.2 Managerial and Strategic Implications

The EDBM framework provides practical insights for managers in the 5G IoT ecosystem, focusing on resource orchestration, adaptation strategies, and multi-actor collaboration to achieve competitive advantage.

1) Effective resource orchestration is critical in a rapidly changing environment

Managers should prioritize flexible, scalable resources such as modular 5G infrastructure that can adapt to shifting IoT demands, like increased bandwidth or latency requirements (Sirmon et al., 2011). Partnerships with ecosystem players, such as cloud providers or device manufacturers, can also enhance resource access, enabling firms to leverage complementary assets for innovation (Gulati et al., 2012).

2) Adaptation is equally essential

The EDBM suggests that firms adopt agile strategies, such as iterative development cycles, to respond to ecosystem changes swiftly (Highsmith & Cockburn, 2001). For example, a smart manufacturing firm might use real-time IoT data to refine its processes, demonstrating the value of continuous learning from ecosystem feedback (Westerlund et al., 2014). This adaptability ensures firms remain competitive amidst technological and market uncertainties.

3) Collaboration across the ecosystem is a cornerstone of the EDBM

Managers should foster strategic alliances to co-create value, such as developing interoperable solutions with software developers or influencing standards with regulators (Rong et al., 2015). Platforms that enable open innovation like shared APIs or co-development hubs can facilitate this process, enhancing ecosystem-wide value creation (Gawer & Cusumano, 2014). For instance, a telecom operator might collaborate with IoT startups to integrate 5G-enabled sensors into smart city applications, amplifying collective impact.

These insights equip managers with a strategic roadmap to balance internal capabilities with external ecosystem dynamics, ensuring sustained performance in the 5G IoT landscape.

4.3 Policy and Regulatory Considerations

The EDBM framework offers valuable implications for policymakers and regulators seeking to foster innovation and sustainability in the 5G IoT ecosystem, with specific applications to its unique regulatory challenges. Policies should aim to enable ecosystem innovation by reducing barriers and encouraging collaboration. Initiatives like funding for R&D consortia or incentives for open standards can stimulate growth and interoperability (Clarysse et al., 2014; Ghosh et al., 2010). Such measures align with the EDBM's emphasis on systemic interactions, promoting a cohesive ecosystem that benefits all stakeholders.

Regulatory challenges in 5G IoT include spectrum allocation, data privacy, and cybersecurity.

The EDBM's systemic perspective suggests that regulations should address not only individual firms but also ecosystem-wide effects. Dynamic spectrum sharing can optimize resource use, while robust data governance frameworks must balance innovation with privacy (Bauer, 2018). Adaptive regulations that evolve with technology such as updating cybersecurity standards for IoT devices are also critical (Weber & Studer, 2016).

Specifically, the EDBM can guide 5G IoT regulation by highlighting key leverage points. For example, policies encouraging infrastructure sharing can accelerate 5G deployment while ensuring equitable access for smaller firms (Cave, 2018). The framework's feedback loops emphasize stakeholder engagement in policy-making, ensuring regulations reflect ecosystem needs (Black & Murray, 2019). This approach can mitigate risks like market concentration or innovation lag while maximizing the societal benefits of 5G IoT, such as enhanced connectivity and smart infrastructure.

By aligning regulatory strategies with the EDBM, policymakers can create an enabling environment that supports innovation, competition, and long-term ecosystem health.

4.4 Limitations and Future Research Directions

While the EDBM offers a robust theoretical foundation, its limitations provide opportunities for future research. The framework's conceptual nature is a primary constraint, lacking empirical validation. Future studies could test its applicability through case studies of 5G IoT implementations, such as analysing how telecom operators adapt during rollouts (Yin, 2017). Longitudinal analyses could further explore the framework's dynamics over time, validating its predictive power.

Operationalizing the EDBM poses methodological challenges. Researchers might develop quantitative metrics like network analysis for ecosystem interactions or indices for adaptive capabilities to facilitate testing (Wasserman & Faust, 1994). Agent-based modelling could also simulate ecosystem behaviours, offering insights into emergent patterns (Railsback & Grimm, 2019).

The framework's focus on 5G IoT raises questions about its generalizability. Comparative studies across ecosystems such as autonomous vehicles or smart grids could assess its broader relevance and identify contextual influences (Eisenhardt, 1989). Additionally, exploring the micro foundations of the EDBM, such as managerial cognition in ecosystem engagement, could deepen its theoretical grounding (Felin et al., 2015).

These directions will refine the EDBM, enhancing its utility for both academia and practice in understanding and managing complex ecosystems.

5. Conclusion

This paper has introduced the EDBM framework as a novel theoretical tool to analyse and understand business model dynamics within the rapidly evolving 5G IoT ecosystem. By synthesizing the RBV, DC, and CAS theories, the EDBM framework offers a multi-faceted perspective that overcomes the shortcomings of applying these theories in isolation to a complex, technology-driven environment. The conclusion aims to summarize the key contributions of this work, spanning theoretical advancements, practical insights, and policy implications, and reflect on their significance for advancing the understanding of 5G IoT ecosystem dynamics and business model innovation.

5.1 Summary of Key Contributions

The primary contribution of this paper lies in the development of the EDBM framework, which integrates RBV, DC, and CAS to provide a comprehensive lens for examining business models in the 5G IoT ecosystem. The Resource-Based View, which traditionally emphasizes the role of valuable, rare, inimitable, and non-substitutable resources in achieving competitive advantage (Barney, 1991), is extended through the EDBM by incorporating dynamic elements that account for the rapid technological change characteristic of 5G IoT. This addresses critiques of RBV's static nature in dynamic contexts (Priem & Butler, 2001). Simultaneously, the inclusion of DC enriches the framework by providing mechanisms for firms to adapt, integrate, and reconfigure their resource base in response to environmental shifts (Teece et al., 1997). Finally, CAS theory enhances the model by capturing the emergent behaviours, feedback loops, and co-evolutionary dynamics that define interactions within the 5G IoT ecosystem (Holland, 1995). This integration represents a theoretical advancement, offering a holistic and innovative approach to studying business model evolution in settings marked by interdependence and technological disruption.

Beyond its theoretical contributions, the EDBM framework provides actionable insights for managers operating within the 5G IoT ecosystem. It underscores the importance of flexible resource orchestration, adaptive strategies, and strategic collaboration across ecosystem stakeholders to sustain competitive advantage (Gulati et al., 2012; Sirmon et al., 2011). The framework highlights how firms can leverage continuous learning and feedback mechanisms to align internal capabilities with external ecosystem dynamics, fostering iterative business model innovation (Westerlund et al., 2014). These insights are particularly pertinent for firms aiming to capitalize on the opportunities presented by 5G technologies, such as enhanced connectivity and data-driven services, while navigating the associated complexities.

Additionally, the EDBM framework offers significant policy implications. It emphasizes the need for adaptive regulatory frameworks that encourage ecosystem-wide innovation, such as incentives for collaboration and the establishment of open standards, while addressing challenges like spectrum allocation and data privacy (Bauer, 2018; Clarysse et al., 2014). By adopting a systemic perspective, the framework suggests that policymakers should consider the broader ecosystem effects of their decisions to maximize societal benefits and promote sustainable growth in the 5G IoT landscape.

5.2 Concluding Reflections

The EDBM framework makes substantial contributions to the understanding of 5G IoT ecosystem dynamics and business model innovation, bridging firm-level strategies with ecosystem-level phenomena. Its integration of RBV, DC, and CAS provides a robust theoretical foundation that not only advances strategic management scholarship but also equips practitioners and policymakers with tools to navigate the complexities of technology-driven ecosystems. The framework's emphasis on co-evolution and emergent behaviours redefines business models as dynamic, adaptive systems rather than static entities, a perspective that is especially relevant in the 5G IoT context where technological advancements and stakeholder interdependencies continuously reshape the competitive landscape.

For the 5G IoT ecosystem, the EDBM framework illuminates pathways for firms to achieve resilience and innovation. By focusing on resource orchestration and ecosystem collaboration, it encourages managers to adopt flexible, iterative strategies that embrace uncertainty and leverage synergies across the value network (Gulati et al., 2012). This shift from traditional, linear business model design to adaptive approaches aligns with the demands of a hyperconnected environment, where success depends on the ability to respond swiftly to technological and market changes (Westerlund et al., 2014). Furthermore, the framework's systemic lens highlights the critical role of policymakers in fostering an enabling environment for innovation, ensuring that the transformative potential of 5G IoT is fully realized (Bauer, 2018).

While the conceptual nature of the EDBM framework necessitates empirical testing to validate its applicability, it establishes a strong foundation for future research. Scholars may explore its relevance across diverse ecosystems, refine its constructs through quantitative and qualitative analyses, or investigate specific mechanisms driving co-evolution in 5G IoT settings. Despite these limitations, the framework's theoretical rigor and practical relevance position it as a valuable contribution to the fields of strategic management and technology innovation.

In conclusion, the EDBM framework marks a significant step forward in understanding business model innovation within the 5G IoT ecosystem. By integrating established theories and tailoring them to the unique challenges of this domain, the paper provides a comprehensive perspective on the interplay between firm strategy, ecosystem dynamics, and technological evolution. Its contributions pave the way for both academic inquiry and practical advancements, offering a lens through which to explore and shape the future of technology-driven ecosystems.

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