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# Exploring the Nexus of Big Data Capabilities, Business Model Innovation, and Firm Performance in Uncertain Environments: A Systematic Review

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## Abstract

This paper provides a systematic review of the literature on big data capabilities, business model innovation, firm performance, and environmental uncertainty. It aims to establish a foundation for theoretical modeling, research proposition refinement, and the overall research framework by meticulously examining the theoretical backgrounds of existing studies and identifying research gaps. An initial search yielded 1,360 articles, which were filtered to remove duplicates and irrelevant studies, resulting in 475 articles for final analysis. These articles were classified into three main categories: the relationship between big data capabilities and business model innovation, the impact of business model innovation on firm performance, and the integrated relationship involving environmental uncertainty. Additionally, it examines the mediating role of business model innovation on firm performance as well as the moderating effect of environmental uncertainty on these relationships. Finally, the paper formulates research hypotheses and discusses identified research gaps, establishing a solid groundwork for methodological discussions in future research and contributing to the advancement of knowledge in the field.

**Keywords:** Big Data Capabilities, Business Model Innovation, Firm Performance, Environmental Uncertainty, Micro, Small, and Medium Enterprises (MSMEs).

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## Introduction

As global digitization accelerates, the application and management of big data have become essential factors in driving organizational success (Popovič et al., 2018). Worldwide, the economic landscape, especially after the pandemic, has seen a significant shift towards digitization and the utilization of big data (Song et al., 2022). The critical role played by big data in enhancing firm performance has attracted the interest of scholars and industry practitioners globally. Among emerging economies, many stand out as particularly dynamic, with micro, small, and medium-sized enterprises (MSMEs) often recognized as the backbone of economic growth (Li, 2024). MSMEs are pivotal to national economic and social development, playing a crucial role in expanding employment, improving livelihoods, and fostering innovation and entrepreneurship. For instance, in China, the contribution of MSMEs to the global economy is underscored by the "56789" summary, indicating that they contribute more than 50% of tax revenue, over 60% of GDP, absorb more than 70% of the rural floating population, provide more than 80% of urban labor employment, and account for more than 90% of the total number of enterprises (Estrader & Zottele, 2023).

The impact of the digital economy and artificial intelligence is evolving from mere technology adoption and consumer connectivity to a new phase of vertical integration with business entities (Kumar & Reinartz, 2016). Traditional development models are being challenged by the continuous digital disruption of knowledge structures and production processes (Adaga et al., 2024). In such a transformational environment, understanding and developing big data capabilities has become important for MSMEs to navigate the opportunities and challenges of big data development (Popovič et al., 2018). This is essential for improving firm performance, promoting sustainable development, and turning crises into opportunities.

While there have been some literature reviews (e.g., Adaga et al., 2024), this study aims to explore how big data capabilities and business model innovations jointly affect the performance improvement of MSMEs through a systematic literature review (SLR). The study aims to address these gaps by establishing a conceptual framework that analyzes how big data capabilities influence MSME performance through business model innovation, considering the moderating effects of environmental uncertainty. By doing so, the study aims

to provide a nuanced understanding of the mechanisms at play and offer practical insights for MSMEs to leverage big data effectively.

The structure of the paper is organized in the following manner: Section 2 provides a comprehensive overview of the theoretical foundations, exploring the broad terrain of big data capabilities and business model innovations. It establishes the key parameters specific to big data, business model innovation, firm performance, and environmental uncertainty. Subsequently, Section 3 presents the research methodology, detailing the approach and techniques employed in the study. The findings from the data analysis are thoroughly examined in Section 4, offering a critical evaluation of the results. Lastly, Section 5 provides a forward-looking perspective, identifying promising directions for future research and summarizing the study's conclusions, practical implications, and any limitations encountered during the research process.

## Literature Review

### Big Data

Although the concept of "big data" has only gained traction in recent years, its origins can be traced back further. In 1980, Alvin Toffler, a renowned American futurist, first mentioned big data in his influential book The Third Wave, describing it as "the colorful music of the Third Wave." By 1998, Cass had focused on the quantitative characteristics of big data in his article titled: "The Big Data Steward," where the term was used to describe enormous data sets. The advent and development of big data have triggered a new technological revolution, produced significant social changes, and created unprecedented economic value (Ferraris et al., 2019; Nguyen et al., 2018). As big data applications penetrate various industries, they have far-reaching impacts on production and daily life, attracting extensive attention from both academic and practical circles (Nguyen et al., 2018).

There is no unified concept for defining big data, as various research institutions, enterprises, and scholars offer different interpretations (Nguyen et al., 2018). Generally, it is agreed that the core of big data lies in quickly capturing information from massive and diverse data. McKinsey defines big data as "huge data sets that are difficult to acquire, store, analyze, and manage with conventional database software because of their sheer volume." Goldner Consulting views big data as a large, fast-growing, and diverse information asset that can improve decision-making efficiency and optimize operational processes through innovative information processing. Big data refers to massive, real-time data streams requiring sophisticated management, processing, and analytical techniques to extract valuable insights (Gupta & George, 2016). Big data capabilities enable companies to utilize emerging technologies for competitive advantage by identifying, acquiring, mining, and analyzing data (Akter et al., 2016; Adaga et al., 2024).

Big data is characterized by the 4Vs: Volume, Variety, Velocity, and Value (Silahtaroğlu & Alayoglu, 2016). Unlike general data, big data provides massive amounts of information, allowing organizations to derive critical insights. However, big data poses significant demands on businesses' ability to access, analyze, and utilize the data. Effective use of big data enables firms to harness personnel's potential, adjust organizational structures, improve business management efficiency, and support performance improvement (Adaga et al., 2024).

**Big Data Capabilities**

In recent years, scholars have examined big data through the lens of dynamic capabilities theory (e.g., Alam Rizvi et al., 2023). This perspective emphasizes that big data is not just an increase in data volume but a dynamic ability to capture complex relationships between data, far beyond the inherent thinking of data presentation. Consequently, big data places higher demands on enterprises regarding technical processing capabilities while offering excellent opportunities for innovation (Silahtaroğlu & Alayoglu, 2016). From the dynamic capabilities perspective, big data is not only an information resource abstracted from the real world but also a core capability that supports real-time analysis and decision-making, providing far-reaching potential value.

The application of big data by enterprises primarily seeks to extract knowledge from dynamically changing data and transform it into business (Adi Sahputra & Nendi, 2024; Silahtaroğlu & Alayoglu, 2016). This dynamic capability enhances organizational flexibility and agility in responding to market changes, further strengthening competitive advantage. Markus (2015) argues that the value of big data lies not in its characteristics but in its effectiveness for enterprises. As a result, scholars have focused on the application capabilities of big data, such as its impact on enterprise decision-making, business model innovation, competitive advantage, and firm performance. Previous studies (e.g., Adi Sahputra & Nendi, 2024; Markus, 2015; Silahtaroğlu & Alayoglu, 2016) contend that simply owning data resources does not confer a competitive advantage; instead, enterprises must effectively integrate, analyze, and utilize these resources.

**Firm Performance**

Surviving and thriving in a dynamic and complex environment is a challenge every enterprise faces. Firm performance is a critical measure of an enterprise's ability to navigate this challenge (Popovič et al., 2018), making it a focal point for entrepreneurs and researchers alike. Understanding firm performance involves clarifying its concept and establishing a clear evaluation system. There are three primary perspectives on defining firm performance:

**1. Results Theory:** This perspective, articulated by Peter Drucker in The Effective Manager and Bernardin (1992), views performance as the direct outcomes of work, encompassing customer satisfaction, return on investment, and strategic objectives (López & Llatas, 2023).

**2. Behavioral Theory:** Campbell (1990) and Murphy (1991) define performance based on observable behaviors that contribute to achieving work objectives (Zajda, 2023).

**3. Holistic Theory:** Brumbach (1988) integrates behaviors, capabilities, and final results, suggesting that performance encompasses both actions and outcomes in completing tasks (Messy et al., 2023).

Measuring firm performance is crucial for understanding an organization's competitive standing and guiding strategic adjustments. Various scholars have proposed different evaluation methods, often categorizing firm performance into dimensions of efficiency, effectiveness, and adaptability. Flynn et al. (2010) included aspects such as operational, market, financial, innovation, and customer service performance. Gronum et al. (2012) emphasized efficiency (profitability and production capacity) and effectiveness (product sales growth). Su et al. (2015) measured performance through net profit growth, sales margin increases, and market share expansion.

**Business Model**

The concept of business models has long been a topic in business literature, but it gained systematic attention and research focus in the late 1990s and early 2000s (Ojala & Baber, 2024). Research on business models evolved towards analyzing firms' strategic and competitive structures, especially with the rise of the Internet and e-commerce in the 1990s. Despite extensive research, there is no unified definition of business models due to varying theoretical perspectives and research purposes (Wirtz et al., 2022).

Business models can be understood through four primary perspectives:

1. Economic Business Model: This perspective emphasizes transforming resources into economic value and gaining a competitive advantage through superior quality, efficient logistics, and optimized revenue streams (Teece, 2010).

2. Operational Business Model: This model focuses on the structural flow of products, services, and information within a firm, highlighting value creation and delivery processes (Wirtz, 2020).

3. Value-Based Business Model: This perspective emphasizes the structures and processes involved in creating value and fostering customer relationships (Munna, 2021).

4. Integration Business Model: This model integrates various elements to generate profitability through strategic arrangements and the effective utilization of resource capabilities (Munna, 2021).

**Business Model Innovation**

Business model innovation (BMI) emerged as a significant concept in the 1990s, extending beyond traditional business models. It acts as a structural foundation for sustainable business growth by guiding companies through market complexities, technological advancements, and evolving customer expectations, as highlighted in the systematic review by Yahaya et al. (2024).

BMI can be classified based on value dimensions and degrees of innovation (Yahaya et al., 2024). Various studies provide insights into this classification. Arash & Ana (2018) propose a value-based perspective, identifying five interdependent BMI elements focused on different facets of a company's business model. Mezger (2014) emphasizes the importance of firms systematically pursuing BMI as a distinct dynamic capability, involving sensing opportunities, developing unique models, and reconfiguring competencies. Additionally, Fallahi's (2017) research distinguishes between purposeful and unintentional BMI processes, highlighting the emergence of new models through problem-solving and shifts between cognitive and experiential search modes. These studies collectively contribute to understanding how BMI can be categorized based on value dimensions and the varying degrees of innovation within organizational contexts.

By leveraging innovative business models, companies can adapt to changing customer expectations, technological disruptions, and environmental imperatives, ensuring long-term growth and success (Wang et al., 2023). Consequently, BMI has become a critical area of research, aiding firms in establishing competitive advantages (Yahaya et al., 2024).

**Environmental Uncertainty**

Environmental uncertainty refers to the unstable and unpredictable characteristics of a firm's external environment. Milliken (1987) defines environmental uncertainty across three dimensions: the unpredictability of future environmental changes, the unpredictability of the impact of these changes on the organization, and the unpredictability of the consequences of firm decisions. These definitions underscore the lack of information and uncertain outcomes that firms experience amid environmental changes. Srivastava et al. (2018) further subdivided environmental uncertainty into state uncertainty, response uncertainty, and impact uncertainty, corresponding to environmental conditions, organizational responses, and the impact of environmental changes on the organization, respectively.

Environmental uncertainty arises from fluctuations in external factors such as the economy, politics, market dynamics, competition, and culture (Afshar Jahanshahi & Brem, 2020). These factors significantly influence business strategy. High degrees of environmental uncertainty make consumer markets, industrial policies, and digital technologies more

unpredictable, thereby increasing the difficulty of resource integration (Srivastava et al., 2018).

With the advent and development of digital technology, environmental uncertainty has intensified (Feng et al., 2024). The rapid advancement of digital technology has exacerbated the challenges enterprises face in accurately judging and assessing the external environment. This amplified uncertainty significantly impacts business management, drawing extensive attention from both academia and industry. For instance, Zhang et al. (2020), analyzing data from 239 manufacturing firms in China, found that environmental uncertainty negatively moderates the relationship between servitization and product innovation. Another study by Holzner & Wagner (2019) revealed that environmental uncertainty moderates the relationship between green innovation and profitability in business models. These findings suggest that uncertainty influences the effectiveness of business models on firm performance.

Despite the risks, environmental uncertainty also presents unexplored opportunities. Firms with the appropriate capabilities can recognize and seize these opportunities, gaining a competitive advantage. As Krishnan et al. (2016) emphasize, "Without uncertainty, achievement may seem mundane even when the pinnacle of business is reached." This paper argues that environmental uncertainty significantly affects companies' development of big data capabilities and business model innovation. This uncertainty is a key external environmental feature of the innovation process, characterized by its dynamism, complexity, and unpredictability.

## Underpinning theory and model related to the study

### Resource-Based Theory

The Resource-Based View (RBV) emerged in the 1980s as a framework for analyzing competitive advantage and profitability in enterprises (Zahra, 2021). RBV posits that a firm's competitive advantage stems from its unique, valuable, and difficult-to-replicate resources and capabilities. These resources include organizational, human, and physical assets, which, when optimized, create a competitive edge. Scholars have noted that big data capabilities, encompassing data acquisition, analysis, integration, and application, are essential resources that can offer firms a substantial competitive advantage (Akter et al., 2016).

### Dynamic Capability Theory

Dynamic Capability Theory (DCT) extends RBV by addressing how firms adapt to rapidly changing environments (Lyu et al., 2024). DCT emphasizes the integration, reconfiguration, and renewal of internal and external capabilities to maintain competitiveness. Key elements include opportunity sensing, capturing, and reconfiguring resources to match environmental changes (Alam Rizvi et al., 2023). Big data capabilities are considered core dynamic

capabilities that enhance organizational agility and innovation, crucial for responding to external uncertainties and maintaining a competitive advantage.

### Innovation Theory

Innovation Theory, introduced by Schumpeter (1912), describes innovation as the process of incorporating new production factors into existing systems. This includes product, technological, market, resource mix, and organizational innovation. Business model innovation, a form of organizational innovation, is vital for translating technological advancements into economic value (Arash & Ana, 2018; Mezger, 2014). In the context of big data, MSMEs can leverage data analytics to develop new business models that enhance competitiveness through open, collaborative, and disruptive innovation (Mezger, 2014).

Together, these theories provide a comprehensive framework for understanding how big data capabilities and business model innovation contribute to firm performance, particularly under conditions of environmental uncertainty. They highlight the importance of continuously evolving and leveraging unique resources and dynamic capabilities to sustain competitive advantage in a rapidly changing market.

## Methodology

This study employs a systematic literature review (SLR) methodology to comprehensively collect, screen, and analyze the relevant literature on big data capabilities, business model innovation, and firm performance. The SLR process involves several well-defined steps, utilizing well-known databases both domestically and internationally to ensure a robust and comprehensive review.

### Literature Search

The initial literature search was conducted using specific keywords across multiple databases. For English-language literature, we searched the Web of Science (WoS), Scopus, and Business Source Complete. For Chinese-language literature, we utilized the China Knowledge Network and Wanfang databases. The search terms included "big data capabilities," "business model innovation," "incremental (exploitative) innovation," "radical (explorative) innovation," "firm performance," and "environmental uncertainty." To ensure thoroughness, supplementary searches were conducted using Google Scholar to identify any studies that might have been missed in the primary databases. The "citation count" function was employed to pinpoint high-impact literature, ensuring the inclusion of pivotal works in our research field. Additionally, Research Rabbit was used to create a knowledge map of literature, which helped in visualizing the logical relationships and progress in the research area.

**Literature Screening and Selection**

The initial search yielded 1,360 articles. We performed a preliminary analysis using Microsoft Excel™ to remove 106 duplicate entries, resulting in 1,254 unique articles. Articles that included keywords related to big data capabilities and business model innovation but were found irrelevant to our specific focus were excluded. This step eliminated 652 articles, narrowing the selection to 602 articles.

A more detailed assessment was then conducted to filter articles specifically discussing the impact of big data capabilities on business model innovation and the subsequent impact on firm performance. We further excluded 127 articles that did not align with our research context, particularly those not focusing on environmental uncertainty in the development of big data capabilities and business model innovation, or those not relevant to Chinese MSMEs. This rigorous screening process left us with 475 articles for in-depth analysis.

**Literature Classification and Coding**

The selected literature was systematically categorized and coded based on themes and methods. The coding process aimed to extract the research questions, methodologies used, and key metrics from each article. The literature was classified into three primary categories:

1. The relationship between big data capabilities and business model innovation,

2. The impact of business model innovation on firm performance, and

3. The integrated relationship among big data capabilities, business model innovation, firm performance, and environmental uncertainty.

Each article underwent a quality assessment to ensure the clarity of research questions, the robustness of methodologies, the appropriateness of sample selection, the construction of theoretical frameworks, and the validity of findings.

To ensure the reliability and validity of our review, each article was meticulously evaluated for quality. This included examining the clarity of research questions, the robustness of the employed methodologies, the appropriateness of the selected samples, the construction of theoretical frameworks, and the validity of findings.

The comprehensive analysis and systematic categorization provided a solid foundation for the subsequent literature review and hypothesis construction. The detailed research methodology employed in this study is illustrated in Figure 1.

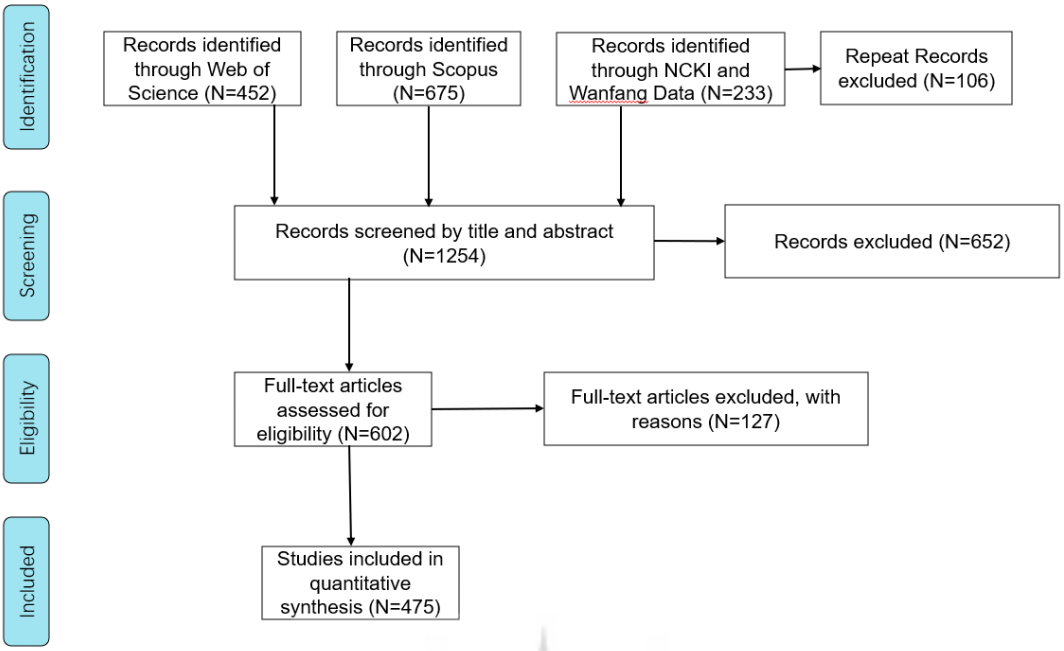


**Figure 1. PRISMA flowchart: Flow of information through the different phases of systematic review.**

Source: Authors' own work

## Results and Discussions

Our systematic review underscores the critical role of big data capabilities in driving business model innovation and enhancing firm performance, especially under conditions of environmental uncertainty. The evidence suggests that while incremental innovations are beneficial in stable environments, radical innovations supported by big data are essential for firms to adapt and thrive in highly dynamic and uncertain contexts.

### Big Data Capabilities and Firm Performance

Our systematic review reveals a consensus in the literature that big data capabilities significantly enhance firm performance (Adi Sahputra & Nendi, 2024; Ejuma Martha Adaga et al., 2024). This enhancement is evident through improved financial returns, operational efficiency, and customer satisfaction. Studies (Ferraris et al., 2019) consistently show that firms with advanced big data capabilities are better equipped to navigate complex market environments and achieve superior business outcomes. This relationship underscores the importance of big data in providing firms with the necessary tools to analyze vast amounts of data, thus supporting strategic decision-making and operational improvements. Based on our literature review, we propose the following hypothesis:

Hypothesis 1: There is a positive relationship between big data capabilities and firm performance in MSMEs.

**Big Data Capabilities and Business Model Innovation**

The literature also highlights the pivotal role of big data capabilities in driving both incremental and radical business model innovations (Alam Rizvi et al., 2023). Incremental innovations involve continuous enhancements to existing products and services, whereas radical innovations lead to profound changes that can disrupt market norms and create new opportunities. Big data capabilities facilitate these innovations by offering deep insights into market trends, customer behaviors, and competitive dynamics, which are crucial for informed decision-making and strategic planning. Drawing from our literature review, we propose the following hypotheses:

Hypothesis 2a: There is a positive relationship between big data capabilities and incremental business model innovation in MSMEs.

Hypothesis 2b: There is a positive relationship between big data capabilities and radical business model innovation in MSMEs.

**Business Model Innovation and Firm Performance**

Our review indicates that incremental business model innovations improve firm performance by optimizing processes, enhancing products, and boosting customer loyalty (Munna, 2021; Teece, 2010). Radical innovations, on the other hand, significantly impact performance by creating new markets and developing unique offerings. Previous studies (Munna, 2021; Yahaya et al., 2024) emphasize the role of business model innovation in driving sustainable growth and maintaining competitive advantage. Based on our literature review, we propose the following hypotheses:

Hypothesis 3a: There is a positive relationship between incremental business model innovation and firm performance.

Hypothesis 3b: There is a positive relationship between radical business model innovation and firm performance.

**Mediating Role of Business Model Innovation**

Many studies (Alam Rizvi et al., 2023) underscore the mediating role of business model innovation in the relationship between big data capabilities and firm performance. Both incremental and radical business model innovations are essential mechanisms through which the benefits of big data capabilities are realized. This mediation highlights the critical function of business model innovation in enabling firms to leverage big data effectively to achieve

superior performance (Wang et al., 2023). Drawing from our literature review, we propose the following hypotheses:

Hypothesis 4a: Incremental business model innovation mediates the relationship between big data capabilities and firm performance.

Hypothesis 4b: Radical business model innovation mediates the relationship between big data capabilities and firm performance.

**Moderating Role of Environmental Uncertainty**

Environmental uncertainty is a significant moderating factor in the relationships between big data capabilities, business model innovation, and firm performance (Zhang et al., 2020). The literature shows that in highly uncertain environments, the positive impact of big data capabilities on firm performance is more pronounced (Chung et al., 2024; Holzner & Wagner, 2019). This is because big data provides firms with the agility to quickly adapt to market changes, foresee shifts in customer demand, and respond to competitive pressures. Based on our review of the literature, we put forward the following hypothesis:

Hypothesis 5: Environmental uncertainty positively moderates the relationship between big data capabilities and firm performance.

However, the relationship between big data capabilities and incremental business model innovation is negatively moderated by environmental uncertainty (Mikalef et al., 2019). Under high uncertainty, incremental innovations become less effective as firms require more radical changes to respond to rapid market shifts. Based on our literature review, we propose the following hypothesis:

Hypothesis 6a: Environmental uncertainty negatively moderates the relationship between big data capabilities and incremental business model innovation.

Conversely, the impact of big data capabilities on radical business model innovation is positively moderated by environmental uncertainty (Wang et al., 2023; Yahaya et al., 2024). Firms are more likely to undertake radical innovations in highly uncertain environments, leveraging big data to identify new opportunities and drive substantial market changes. Drawing from these insights, the following hypotheses are proposed in this study:

Hypothesis 6b: Environmental uncertainty positively moderates the relationship between big data capabilities and radical business model innovation.

**Moderated Mediation**

Previous studies further explore the role of environmental factors, notably dynamism and competitiveness (Feng et al., 2024), as moderators in the relationship between different types of innovation and firm performance (Holzner & Wagner, 2019; Zhang et al., 2020). These studies reveal that in rapidly evolving technological and market environments, firms are compelled to innovate their business models, reinforcing core competencies such as dynamic capabilities, resource integration, and technological innovations, which are pivotal for enhancing firm performance.

While incremental innovations may improve operational efficiency and customer satisfaction in stable environments, their capacity to adequately respond to rapid changes in market demand and technological trends is limited in highly dynamic and uncertain contexts. Drawing from these insights, the following hypothesis is proposed in this study:

Hypothesis 7a: Environmental uncertainty negatively moderates the relationship between incremental business model innovation and firm performance.

On the other hand, firms embracing radical and groundbreaking business model innovation strategies are better positioned to adapt to market changes and seize emergent business opportunities (Haddad et al., 2020). These strategies are essential for achieving excess profits and sustainable growth. Based on these insights, we propose the following hypothesis:

Hypothesis 7b: Environmental uncertainty positively moderates the relationship between radical business model innovation and firm performance.

The study delves further into the nuanced mediating effects moderated between these variables. Incremental business model innovations may manifest distinct differences in mediating the relationship between big data capabilities and firm performance (Ferraris et al., 2019; Mezger, 2014). In uncertain environments, the information provided by big data capabilities can rapidly become obsolete, posing significant limitations for firms predominantly reliant on incremental innovation. From this analysis, we propose the following hypothesis:

Hypothesis 8a: Environmental uncertainty negatively moderates the mediating effect of incremental business model innovation between big data capabilities and firm performance.

Conversely, radical business model innovation, supported by big data capabilities, is more likely to yield significant positive impacts in high-uncertainty environments (Yahaya et al., 2024). These capabilities enable firms to discern market demands, integrate resources, and optimize resource allocation, thereby enhancing enterprise performance. Given these conclusions, we present the following hypothesis:

Hypothesis 8b: Environmental uncertainty positively moderates the mediating effect of radical business model innovation between big data capabilities and firm performance.

Figure 2 shows the proposed research framework, which is based on the eight hypotheses.

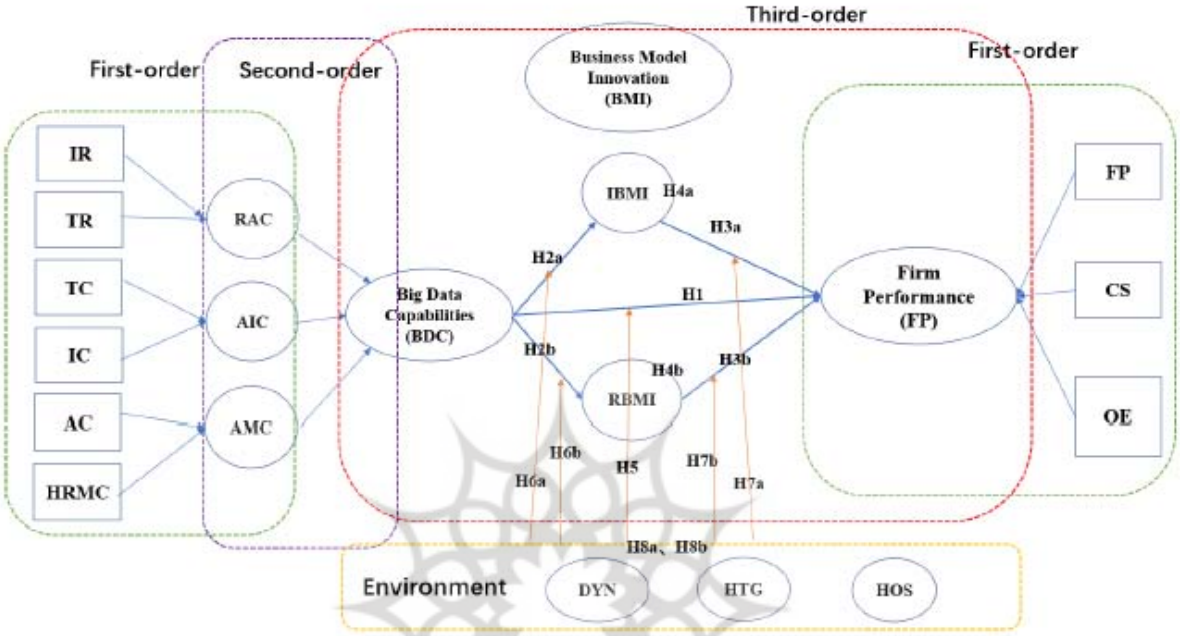


**Figure 2. Research Framework**

Source: Authors' work

## Conclusion

This paper provides a comprehensive systematic review of the literature on big data capabilities, business model innovation, firm performance, and environmental uncertainty. The primary goal of this study was to establish a robust foundation for theoretical modeling, refine research propositions, and develop a comprehensive research framework by meticulously examining the theoretical backgrounds of existing studies and identifying critical research gaps.

Our review confirms that big data capabilities significantly enhance firm performance by improving financial returns, operational efficiency, and customer satisfaction. These capabilities enable firms to effectively navigate complex market environments, thus supporting strategic decision-making and operational improvements. The literature review emphasizes the important role of big data capabilities in driving both incremental and radical business model innovations. Incremental innovations involve continuous enhancements to existing products and services, while radical innovations lead to profound changes that disrupt

market norms and create new opportunities. Business model innovation serves as a crucial mediator in the relationship between big data capabilities and firm performance, allowing firms to leverage big data effectively to achieve superior outcomes.

Environmental uncertainty emerges as a significant moderating factor, intensifying the positive impact of big data capabilities on firm performance in highly dynamic contexts. However, incremental innovations become less effective under high uncertainty, necessitating more radical changes to respond to rapid market shifts.

This study offers valuable practical insights for MSMEs, guiding them on how to leverage big data to navigate complex market landscapes and achieve sustainable growth. Future research should prioritize the empirical testing of the proposed hypotheses and further explore the nuanced impacts of various types of business model innovations across different environmental contexts. By doing so, we can enhance our understanding of the mechanisms through which big data capabilities influence firm performance, particularly under conditions of environmental un-certainty. Future research should prioritize the empirical testing of these hypotheses and delve into the nuanced impacts of various types of business model innovations across different environmental contexts.

## Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.



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