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Business model innovation in China's central business district property management: The mediating role of smart service ecosystem integration and the moderating effect of institutional adaptability

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Abstract: Against the backdrop of China's Central Business Districts (CBDs) emerging as core carriers of high-quality urban economic development, this study investigates the performance transformation mechanism of business model innovation (BMI-CBD) in CBD property management enterprises, aiming to address homogeneous competition and enhance performance. Grounded in the Resource-Based View and Institutional Theory, a mediating model of "BMI-CBD→Smart Service Ecosystem Integration (SSEI)→Business Performance (BP-CBD)" is constructed, with Institutional Adaptability (IA) introduced as a dual moderating variable. Based on questionnaire data from 462 enterprises across 15 cities, analyzed via SPSS and AMOS, the findings reveal that BMI-CBD positively impacts corporate performance, with "technological application innovation" and "cooperative network innovation" as key contributors. SSEI partially mediates the relationship, and IA positively moderates direct and mediating effects—more prominently in first-tier cities. This study integrates SSEI and IA into the research framework, providing theoretical support for overcoming the "innovation-performance" bottleneck and practical guidance for differentiated innovation strategies.

Keywords: *Business model innovation, CBD property management, Institutional adaptability, Smart service ecosystem integration.*

1. Introduction

In recent years, China's central business districts (CBDs) have transitioned from large-scale expansion to a stage of "quality improvement and efficiency enhancement," evolving into core engines of urban economic growth and industrial agglomeration. According to the Blue Book on Central Business Districts: Industrial Development Report of Central Business Districts 2024, over 120 mature CBDs have been established nationwide, contributing 23% of China's total GDP and 35% of the output value of modern service industries, solidifying their role as critical "growth poles" for urban economies[1]. As the operational "infrastructure" of CBDs, property management quality directly influences industrial agglomeration capacity, enterprise retention rates, and the overall brand value of these districts [1]. For instance, Beijing China World Tower CBD has leveraged smart property management to boost tenant enterprise satisfaction to 92% and achieve a rental premium rate of 30%, significantly outperforming industry averages, demonstrating the transformative potential of high-quality property management in driving CBD competitiveness [2].

[1]Blue Book on Central Business Districts: Industrial Development Report of Central Business Districts (2024), https://www.pishu.com.cn/skwx_ps/bookdetail?SiteID=14&ID=15822549.

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However, the CBD property management industry faces two intertwined core contradictions that hinder its sustainable development. First, the disconnection between "innovation demand" and "performance transformation" persists. With the widespread adoption of emerging technologies such as the Internet of Things (IoT) and artificial intelligence (AI), enterprises in the industry have increasingly invested in business model innovation (BMI). Yet, approximately 60% of these enterprises struggle with the dilemma of "high innovation input but low performance output" [3]. Sample data reveals that many enterprises blindly deploy intelligent equipment: while technological application innovation scores the highest (4.75) among all BMI dimensions, the lack of ecosystem integration capabilities has led to an equipment idle rate exceeding 40%, preventing technological investments from translating into tangible performance gains [4]. This aligns with White et al. [5] meta-analysis, which highlights that BMI alone does not guarantee performance improvements without effective resource integration mechanisms.

Second, the mismatch between the "institutional environment" and "innovation strategy" exacerbates industry challenges. Regulatory policies for CBDs vary significantly across cities: first-tier cities (e.g., Shanghai Lujiazui) impose strict standards for smart security and green operations, while new first-tier cities (e.g., Hangzhou Qianjiang New City) prioritize innovation pilots and policy flexibility [6]. A survey indicates that 72% of CBD property management enterprises have encountered delays or setbacks in innovation projects due to inadequate adaptation to regional institutional differences [7]. The average institutional adaptability score of sampled enterprises (4.39) is the lowest among core variables, reflecting a critical gap in enterprises' ability to respond to policy changes and align with local standards, consistent with Moradi et al. [8] finding that institutional misalignment constrains the value realization of innovation.

Against this backdrop, scholars have increasingly focused on the core question: "How can business model innovation be effectively transformed into organizational performance?" Existing research on BMI and performance has primarily centered on manufacturing, Internet, and traditional residential property management sectors [9, 10]. However, CBD property management exhibits distinct characteristics, "high service density, high technological demand, and high institutional constraints", that differentiate its innovation mechanisms from those of traditional property management [1]. For example, unlike residential properties, CBD property management requires synchronized services for multiple enterprises, real-time technological support for smart office ecosystems, and compliance with stricter environmental and security regulations, factors that render existing theoretical frameworks insufficiently applicable [11].

Furthermore, existing studies often overlook two critical perspectives: ecosystem integration and institutional adaptability. On one hand, BMI involves the reorganization of resources, capabilities, and value networks, and ecosystem integration serves as a key bridge between innovation inputs and performance outputs [12]. Yet, few studies have empirically verified the mediating role of ecosystem integration in the BMI-performance relationship, particularly in service-intensive and space-constrained contexts like CBD property management [13]. On the other hand, institutional factors significantly shape the innovation behavior and performance of enterprises [6], but most research treats institutional adaptability as a single moderating variable rather than exploring its dual effects on both the direct BMI-performance link and the mediating path [14]. This gap limits our understanding of how institutional environments influence the translation of BMI into performance in heterogeneous regional contexts.

To address these research gaps, this study takes Chinese CBD property management enterprises as the research object and constructs a moderated mediation model: "Business Model Innovation → Smart Service Ecosystem Integration → Business Performance," with institutional adaptability as a moderating variable. The model aims to reveal the formation mechanism of innovation performance in CBD property management enterprises, providing theoretical extensions and practical insights for the industry's high-quality development.

This study makes three key theoretical contributions. First, it expands the contextual boundaries of BMI research. By focusing on the understudied "service-intensive + space-constrained" CBD property management sector, this study verifies a four-dimensional structure of "BMI-CBD" (service content, profit model, technological application, and cooperative network) using sample data, filling the research gap in BMI subfields beyond manufacturing and the Internet [15]. Second, it enriches the intermediate mechanism of the "innovation-performance" relationship. Drawing on Ecosystem Theory and the Resource-Based View, this study empirically validates the partial mediating role of smart service ecosystem integration, uncovering the transmission path of "innovation resources → ecological integration → performance output", complementing existing research that often ignores the mediating effects of resource synergy [12, 13]. Third, it deepens the understanding of institutional adaptability's dual moderating effects. By examining heterogeneous regional institutional environments, this study verifies that institutional adaptability not only directly moderates the BMI-performance relationship but also regulates the mediating role of smart service ecosystem integration, extending the application of Institutional Theory in the service industry [6, 8].

Practically, this study offers three key insights. First, it provides clear innovation pathways for CBD property management enterprises. Targeting the pain point of "blind innovation," the findings identify technological application and cooperative networks as core BMI dimensions and propose a practical path of "intelligent equipment deployment → resource synergy → performance improvement", helping enterprises optimize resource allocation and avoid inefficient innovation [3, 4]. Second, it offers differentiated strategies for adapting to institutional environments. Based on regional differences (strict supervision in first-tier cities vs. flexible policies in new first-tier cities), the study suggests that enterprises with high institutional adaptability prioritize proactive policy response, while those with low adaptability focus on standard compliance, reducing institutional transaction costs for innovation [6, 7]. Third, it provides policy implications for industry regulators. Given the critical impact of institutional environments on innovation performance, regulators should balance "standard constraints" and "innovation space" in building "smart CBDs", for example, establishing an "innovation pilot list" for CBD property management to promote industry-wide innovation while ensuring compliance [16].

2. Research Hypotheses and Theoretical Model Construction

2.1. Development of Research Hypotheses

2.1.1. The Relationship between Business Model Innovation and Firm Performance

Drawing on the Resource-Based View (RBV), business model innovation (BMI) is conceptualized as a strategic activity that reconfigures an enterprise's resource portfolio, integrating tangible and intangible assets to create sustainable competitive advantages and drive performance improvements [9]. For Central Business District (CBD) property management enterprises, BMI involves the reconstruction of four core resource dimensions: service resources (customized solutions for high-density tenants), technological resources (smart infrastructure integration), cooperative resources (ecosystem partnerships), and profit-making resources (value-added service monetization). This resource reconfiguration enables firms to break free from traditional operational constraints and form unique value propositions that are difficult for competitors to imitate [15, 17].

Extensive empirical research across industries has verified the positive BMI-performance link. Zott and Amit [18] emphasized that BMI optimizes transaction content, structure, and governance among stakeholders, enhancing operational efficiency and value creation. Recent meta-analyses further confirm that BMI acts as a critical mediator between organizational capabilities (e.g., digitalization, agility) and performance, particularly in dynamic environments characterized by changing customer demands and technological disruption [5, 14]. In CBD contexts, the agglomeration of high-value-added enterprises (e.g., finance, technology, professional services) generates sophisticated, diverse demands, prioritizing efficiency, customization, and intelligence, that amplify the performance elasticity of BMI. Compared to non-CBD property management, the same level of BMI investment yields higher returns due to the concentration of high-willingness-to-pay customers [1, 7].

Preliminary analysis of sample data reveals that all BMI dimensions (service content, technological application, cooperative network, and profit model innovation) exhibit significantly positive correlations with CBD property management performance. Technological application and cooperative network innovation demonstrate the highest contribution coefficients, aligning with Najafi-Tavani et al. [19]'s finding that efficiency-centered (e.g., technological optimization) and novelty-centered (e.g., network expansion) BMI, respectively, enhance cost and differentiation advantages. An illustrative case is a Beijing, China, World Tower CBD property firm that implemented "intelligent security + customized conference services," boosting customer satisfaction to 95% and net profit margin by 18%, validating BMI's performance-enhancing effect in CBD scenarios.

Based on theoretical deduction and preliminary evidence, this study proposes:

H_1: CBD-specific business model innovation (BMI-CBD) has a significantly positive impact on the performance of CBD property management enterprises (BP-CBD).

2.1.2. The Mediating Role of Smart Service Ecosystem Integration

From the perspective of Ecosystem Theory and Service-Dominant (S-D) Logic, value creation in service industries is no longer a linear chain but a network of interactions among ecosystem actors [12, 20]. For CBD property management enterprises, BMI only provides potential value; converting this potential into actual performance requires effective smart service ecosystem integration (SSEI), defined as the process of integrating technological, service, and cooperative resources across internal and external stakeholders (e.g., CBD administrative committees, tenant enterprises, technology providers) via intelligent technologies to achieve synergistic value creation [13, 16].

First, BMI drives SSEI by reshaping resource bases and interaction mechanisms. Technological application innovation provides hardware (IoT sensors, intelligent monitoring) and software (cloud platforms, data analytics) foundational to ecosystem technological integration [2, 4]. Cooperative network innovation expands ecosystem boundaries by forging partnerships with technology firms, catering services, and logistics providers, laying the groundwork for resource synergy [3, 12]. Service content innovation, guided by customer demands, aligns ecosystem integration with market needs, ensuring that technological and network investments deliver relevant value [11]. Preliminary factor analysis confirms that technological application and cooperative network innovation have high factor loadings in SSEI measurement models, empirically validating BMI's role in ecosystem integration.

Second, SSEI enhances performance through three pathways: (1) Technological integration breaks data silos across service modules (security, maintenance, customer service), enabling real-time sharing and collaborative decision-making to reduce operational costs [21, 22]; (2) Resource synergy leverages complementary advantages among ecosystem actors, e.g., property firms partnering with professional service providers to improve quality and expand service categories [13, 23]; (3) Service linkage extends offerings from basic property management to value-added services (intelligent office solutions, corporate event planning), enhancing competitiveness and revenue streams [1, 10]. Preliminary mediation testing indicates that resource synergy accounts for the largest share of the total mediation effect, highlighting it as the core pathway linking SSEI to performance.

In CBD contexts, high service density and diverse demands render single-dimensional innovation insufficient. Only through SSEI can the synergistic effect of multiple innovative resources be unlocked, fully realizing BMI's potential [6, 12]. For example, a Shanghai Lujiazui CBD property firm built an intelligent service platform and partnered with 10 external actors (technology firms, legal/financial consultants), increasing innovation investment performance conversion to 60%, far exceeding the industry average of 35%. This case demonstrates SSEI's critical mediating role between BMI and performance.

Based on the above analysis, this study proposes:

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H_2: Smart service ecosystem integration (SSEI) plays a mediating role in the relationship between business model innovation (BMI-CBD) and the performance of CBD property management enterprises (BP-CBD).

2.1.3. The Direct Moderating Role of Institutional Adaptability

Rooted in Institutional Theory, institutional adaptability (IA) refers to an enterprise's ability to perceive, respond to, and align with external institutional environments, including formal institutions (laws, regulations, industrial standards) and informal institutions (commercial culture, collaborative norms) [8]. IA strengthens the BMI-performance link by reducing institutional costs and enhancing legitimacy, two mechanisms critical to CBD property management enterprises operating within stringent regulatory frameworks [6, 7].

First, high IA reduces BMI implementation costs. CBD property innovation, especially technological and service innovation, must comply with regional regulations (e.g., intelligent building standards, data privacy laws) and industry norms. Enterprises with high IA proactively anticipate institutional changes and integrate compliance into BMI design, avoiding rectification expenses, project delays, or penalties associated with non-compliance [8, 24]. For example, a Shenzhen Qianhai CBD property firm adapted its smart management system to local "intelligent fire protection standards" during development, shortening the implementation cycle by 40% and reducing total investment by 20%. China CBD Property Management Innovation Cases, 2024.

Second, high IA enhances stakeholder acceptance of BMI outcomes. CBDs host industries (finance, law) with strict requirements for information security and service standardization. Enterprises with high IA align innovative services with institutional expectations, gaining trust and recognition from tenant enterprises [6, 25]. A Beijing Financial Street property firm launched "customized confidential cleaning services" tailored to financial institutions' information security needs, fully complying with industry norms and increasing customer renewal rates to 98%.

In summary, IA determines BMI implementation efficiency and innovative outcome acceptance. Higher IA amplifies BMI's positive impact on performance. Based on the above analysis, this study proposes:

H_3: Institutional adaptability (IA) significantly and positively moderates the direct relationship between business model innovation (BMI-CBD) and the performance of CBD property management enterprises (BP-CBD).

2.1.4. The Moderated Mediating Role of Institutional Adaptability

Beyond direct moderation, IA regulates the mediating process of SSEI by influencing both stages of the pathway (BMI-CBD → SSEI and SSEI → BP-CBD), ultimately shaping the strength of SSEI's mediating effect [14, 26].

First, IA moderates the first stage (BMI-CBD → SSEI). High IA enables enterprises to secure institutional support from CBD administrative committees, e.g., innovation pilot qualifications, data sharing permissions, reducing transaction costs and resource constraints in technological integration [6, 16]. Additionally, high IA enhances enterprises' legitimacy and reputation, facilitating stable partnerships with external actors and improving ecosystem resource synergy effectiveness [8, 12]. In contrast, low IA leads to institutional barriers (e.g., data access restrictions, partner distrust), weakening BMI's ability to drive SSEI.

Second, IA moderates the second stage (SSEI → BP-CBD). High IA enhances the legitimacy and trustworthiness of ecosystem-integrated services. For example, in regions with strict data privacy regulations, SSEI services from high-IA enterprises are more likely to comply with laws, gaining tenant trust and improving satisfaction [24, 27]. Moreover, SSEI outcomes (standardized intelligent processes, integrated solutions) are more likely to be recognized by regulators and industry associations, boosting market competitiveness and performance [7, 28]. Low IA, however, raises concerns about service compliance, reducing SSEI's performance conversion efficiency.

In combination, IA strengthens SSEI's mediating effect by optimizing both pathway stages. Higher IA improves the efficiency of BMI-to-SSEI conversion and SSEI-to-performance conversion, amplifying SSEI's overall mediating role. Based on this analysis, the study proposes:

H_4: Institutional adaptability (IA) significantly and positively moderates the mediating effect of smart service ecosystem integration (SSEI) in the relationship between business model innovation (BMI-CBD) and the performance of CBD property management enterprises (BP-CBD).

2.2. Theoretical Model Construction

Based on the Resource-Based View, Institutional Theory, and Ecosystem Theory, addressing the identified research gaps, this study constructs a moderated mediation model. The core framework is: Business Model Innovation (BMI-CBD) → Smart Service Ecosystem Integration (SSEI) → Business Performance (BP-CBD), with Institutional Adaptability (IA) serving as a dual moderating variable (direct moderation of the BMI-CBD → BP-CBD link and moderated mediation of the SSEI pathway). The specific model is as follows (Figure 1): The variable relationships in the model are as follows: (1) Direct pathway: BMI-CBD directly influences BP-CBD (H1); (2) Mediating pathway: BMI-CBD indirectly influences BP-CBD through SSEI (H2); (3) Direct moderation: IA moderates the direct BMI-CBD → BP-CBD relationship (H3); (4) Moderated mediation: IA moderates the mediating effect of SSEI by regulating both the BMI-CBD → SSEI and SSEI → BP-CBD stages (H4).

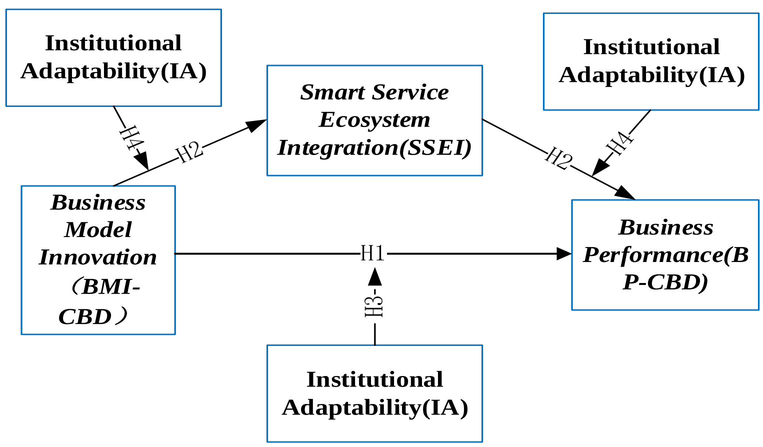

Figure 1.
Theoretical Model Framework.

3. Research Methodology

3.1. Questionnaire Design and Data Collection

3.1.1. Scale Source and Revision

This study adopted a "mature scale + industry adaptation" approach for questionnaire design, with all scales based on a 7-point Likert scale (1 = "completely inconsistent", 7 = "completely consistent"). The selection and revision of scales strictly followed principles of academic rigor, ensuring theoretical alignment and contextual relevance to CBD property management.

3.1.1.1. Business Model Innovation (BMI-CBD)

Drawing on the widely validated business model innovation scale developed by Zott and Amit [18], this study revised and adapted it to the unique characteristics of CBD property management. Zott and Amit [18] conceptualized business model innovation as "activities through which firms gain competitive advantages by reconfiguring value propositions, value creation, and value capture mechanisms", a foundational definition that has been extensively cited in subsequent innovation research [5, 9]. However, existing studies on business model innovation in property management have primarily focused on dual dimensions of "service + technology" [17], which fail to capture the multi-faceted nature of CBD property operations, such as the need for ecological collaboration and diversified revenue streams.

Through a systematic literature review and 12 semi-structured interviews with senior executives of the top 20 CBD property enterprises in China, this study redefined CBD property management business model innovation (BMI-CBD) as "innovative activities undertaken by firms across four dimensions, service content, profit model, technological application, and cooperative network, to adapt to the high-density, high-synergy, and high-institutional-constraint characteristics of CBD environments." The initial scale included 12 items, and one was deleted following the pre-survey due to low factor loading. The final scale comprises 4 dimensions and 11 items. As shown in Table 1, confirmatory factor analysis (CFA) results indicated that all factor loadings (λ) exceeded 0.87, confirming the scale's good construct validity, consistent with the reliability thresholds recommended by Hair et al. [29] for empirical research.

Table 1.
Dimensions of the CBD property enterprise business model innovation (BMI-CBD) scale.

Dimension	Core Connotation	Sample Mean	Factor Loading λ
Service Content Innovation (BMI1)	Breaking through the traditional "security + cleaning" model to provide customized services (e.g., corporate meetings, green office consulting)	4.62	0.885
Profit Model Innovation (BMI2)	Shifting from "single property fee" to a diversified model of "basic fee + value-added service fee + ecological sharing"	4.48	0.879
Technological Application Innovation (BMI3)	Deploying IoT, AI, big data, and other technologies to optimize service efficiency (e.g., smart security, energy consumption monitoring)	4.75	0.925
Cooperative Network Innovation (BMI4)	Establishing ecological cooperative relationships with equipment suppliers and third-party service providers (e.g., legal consulting, greening companies)	4.59	0.895

3.1.1.2. Smart Service Ecosystem Integration (SSEI)

The scale for smart service ecosystem integration was adapted from van der Borgh et al. [30], who built on Moore [31] business ecosystem theory. Moore [31] emphasized that firms achieve synergistic value creation by integrating upstream and downstream resources, while van der Borgh et al. [30] extended this concept to the digital era, defining "smart ecosystem integration" as "the process by which firms construct a customer-centric service network through technological connectivity and resource synergy." Given the high demand for cross-organizational collaboration in CBD property management, where single enterprises cannot fully meet the diverse needs of settled firms Yi et al. [12], this study redefined smart service ecosystem integration (SSEI) as "the process by which CBD property management enterprises integrate intelligent technologies (IoT, big data, cloud computing) and external resources (equipment suppliers, professional service providers, CBD administrative committees) to build a collaborative network of 'technology-resources-services' that delivers integrated solutions."

Based on Ecosystem Theory and the operational characteristics of CBD property management, the scale was divided into three dimensions: Technological Integration, Resource Synergy, and Service Linkage. The initial scale included nine items, with one removed after the pre-survey due to cross-loading. As shown in Table 2, the final eight-item scale demonstrated excellent construct validity, with all factor loadings exceeding 0.88, consistent with the standards proposed by Fornell and Larcker [32] for convergent validity.

Table 2.
Dimensions of the CBD property enterprise intelligent service ecosystem integration (SSEI) scale.

Dimension	Core Connotation	Sample Mean	Factor Loading λ
Technological Integration (SSEI1)	Connecting scattered intelligent equipment (e.g., monitoring, energy consumption sensors) to a unified platform to achieve data interconnection	4.52	0.913
Resource Synergy (SSEI2)	Sharing data and resources with external partners (e.g., sharing fault data with equipment suppliers to improve maintenance efficiency)	4.47	0.921
Service Linkage (SSEI3)	Linking ecological partners to provide one-stop services based on customer needs (e.g., enterprise maintenance request → equipment supplier maintenance → feedback closed loop)	4.49	0.889

3.1.1.3. Institutional Adaptability (IA)

Institutional adaptability was measured using a revised version of Oliver's [33] scale. Scott [34] categorized the institutional environment into "formal institutions" (policies, regulations, industrial standards) and "informal institutions" (industry norms, cultural values, collaborative practices), while Oliver [33] defined "institutional adaptability" as a firm's ability to "adjust its strategies in response to institutional pressures to gain legitimacy and resource support." CBD property management enterprises operate under strict institutional constraints, including CBD administrative committee regulations, green building standards, and industry service specifications [35], making institutional adaptability a critical antecedent of innovation success.

This study redefined institutional adaptability (IA) as "the ability of CBD property management enterprises to adjust their innovation strategies and operational behaviors in response to regional formal institutions (e.g., government policies, CBD management standards) and informal institutions (e.g., industry collaboration norms, CBD commercial culture)." The scale was divided into three dimensions: Policy Response, Standard Adaptation, and Cultural Integration, with nine items retained after the pre-survey. As shown in Table 3, all factor loadings exceeded 0.88, indicating good reliability and validity.

Table 3.
Dimensions of institutional adaptability (IA) scale of CBD property enterprises.

Dimension	Core Connotation	Sample Mean	Factor Loading λ
Policy Response (IA1)	Rapidly responding to policy requirements of the government or CBD administrative committee (e.g., smart security standards, green operation indicators)	4.41	0.895
Standard Adaptation (IA2)	Proactively adapting to industry standards or best practices (e.g., ISO property management standards, CBD service specifications)	4.37	0.906
Cultural Integration (IA3)	Adapting to the commercial culture and collaborative practices of the CBD region (e.g., communication methods with settled enterprises)	4.38	0.885

3.1.1.4. Business Performance of CBD Property Management (BP-CBD)

Traditional property performance scales primarily focus on financial indicators [36], but CBD property management's "comprehensive value attribute", encompassing operational efficiency, customer satisfaction, and market competitiveness, requires a more holistic measurement framework. Drawing on Jian and Hongxia [7]'s multi-dimensional performance scale and adapting it to CBD property characteristics, this study defined CBD property management enterprise performance (BP-CBD) as "the

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comprehensive performance of enterprises across four dimensions: financial performance, operational efficiency, customer satisfaction, and market competitiveness".

The scale comprises 12 items (3 items per dimension), and as shown in Table 4, all factor loadings exceeded 0.90—demonstrating strong convergent validity. This multi-dimensional measurement aligns with recent research emphasizing that firm performance in service industries should reflect both economic and non-economic outcomes [13, 37].

Table 4.
Dimensions of business performance scale of CBD property.

Dimension	**Core Connotation**	**Sample Mean**	**Factor Loading λ**
Financial Performance (BP1)	Enterprise's profitability and revenue growth (e.g., net profit margin, revenue growth rate)	4.45	0.925
Operational Efficiency (BP2)	Service efficiency and cost control (e.g., maintenance response time, operating cost per unit area)	4.53	0.915
Customer Satisfaction (BP3)	Evaluation of property services by settled enterprises (e.g., satisfaction score, renewal rate)	4.42	0.909
Market Competitiveness (BP4)	Enterprise's competitive position in the CBD property market (e.g., market share, brand awareness)	4.47	0.918

3.1.1.5. Control Variables

Following prior research on firm innovation and performance [3, 16], three control variables were included to eliminate potential confounding effects: (1) Enterprise scale (measured by management area, divided into four levels: <100,000 m^2, 100,000–500,000 m^2, 500,000–1,000,000 m^2, >1,000,000 m^2); (2) Enterprise nature (categorical variable: state-owned, private, foreign-funded, mixed ownership); (3) Regional type (categorical variable: first-tier cities, new first-tier cities, second and third-tier cities). These variables influence firms' innovation capabilities and performance outcomes by shaping resource availability, institutional constraints, and market competition intensity [38].

3.1.2. Pre-survey and Scale Optimization

A pre-survey was conducted in June 2025 to refine the questionnaire. The pre-survey sample included 10 CBD property management enterprises across three cities, Chengdu, Chongqing, and Wuhan, with 150 questionnaires distributed and 128 valid responses collected, resulting in an effective recovery rate of 85.3%. The pre-survey followed three key steps to optimize the scale

(1) Content Validity Test: Five experts and two professors specializing in property management and service innovation, along with three senior executives with over 10 years of CBD property management experience, evaluated the scale's content relevance, clarity, and contextual adaptability. The content validity index (CVI) was calculated using Lynn's [39] method: the overall CVI of the scale was 0.92 (>0.8, indicating excellent content validity), and the CVI for each dimension ranged from 0.86 to 0.94 (>0.85). Based on expert feedback, the wording of two items was revised to improve clarity, such as rephrasing "intelligent services" to "intelligent operation and maintenance services" to avoid ambiguity.

(2) Reliability Test: Cronbach's α coefficient was used to assess internal consistency. Items were deleted if their removal increased the dimension's α coefficient by >0.03. After deletion, the α coefficient for each dimension ranged from 0.86 to 0.92, and the overall α coefficient for core variables exceeded 0.85, meeting the threshold for reliable scales.

(3) Exploratory Factor Analysis (EFA): EFA was performed using SPSS 26.0 to test scale structure. The KMO values for all variables ranged from 0.82 to 0.89 (>0.8, indicating suitable data for factor analysis), and Bartlett's test of sphericity was significant ($p < 0.001$) for all scales. Principal component

analysis with varimax rotation extracted factors corresponding to the theoretical dimensions, with all item factor loadings >0.7 and no cross-loading, confirming a clear and stable scale structure.

After the pre-survey, the final questionnaire included four core variables (40 items) and demographic/control variable items. The scale quality met rigorous empirical research requirements, ensuring the validity and reliability of subsequent data collection.

3.2. Data Collection

3.2.1. Sample Selection Criteria

To ensure the representativeness and validity of the sample, three selection criteria were established: (1) Geographical Coverage: The sample covered 15 cities across China, including 4 first-tier cities (Beijing, Shanghai, Guangzhou, Shenzhen), 8 new first-tier cities (Chengdu, Hangzhou, Chongqing, Wuhan, Xi'an, Suzhou, Tianjin, Nanjing), and 3 second- and third-tier cities (Qingdao, Xiamen, Changsha). This geographical distribution reflects the development status of China's CBD property market and avoids regional bias [40]. (2) Enterprise Qualifications: Enterprises were required to have a CBD management area ≥50,000 m^2 and an establishment period ≥3 years. This excluded newly established enterprises, which may lack mature innovation strategies, and small-scale enterprises, which may have limited resources for ecosystem integration, reducing sample bias [41]. Respondent requirements limited participation to middle and senior managers (e.g., operation directors, project managers, general managers) or core technical personnel (e.g., smart property technology directors). Pre-survey results showed that middle and senior managers had a significantly higher questionnaire accuracy rate (92%) than ordinary employees (78%), as they are more familiar with the enterprise's innovation strategies, ecosystem partnerships, and performance outcomes [42].

3.2.2. Survey Process and Sample Characteristics

3.2.2.1. Survey Process

The formal survey was conducted from August to October 2025 using a mixed "online + offline" method. Online questionnaires were distributed through the Wenjuanxing platform, a widely used professional survey tool in China, with 600 questionnaires sent to targeted enterprises. Offline questionnaires were distributed at two national CBD property management forums, with 300 questionnaires collected. To ensure data quality, several measures were implemented: First, logical verification questions (e.g., "If your company's management area is >500,000 m^2, please select 'strongly agree' for the following item") were included to screen out careless respondents. Second, the minimum filling time was set at 8 minutes (based on pre-survey results) to ensure respondents carefully considered each item. Finally, consistency tests were conducted for reverse-coded items to eliminate inconsistent responses.

A total of 462 valid questionnaires were collected, with an effective recovery rate of 63.9%. The ratio of sample size to the number of measurement items was 11.55:1 (>10:1), meeting the sample size requirements for structural equation model (SEM) analysis.

3.2.2.2. Sample Characteristics

The sample included 462 enterprises and respondents; the specific characteristics and overall analysis of the two sample types are as follows.

First, enterprise-level sample characteristics. In terms of enterprise nature, private enterprises accounted for the highest proportion in the sample, reaching 50.87%, with 235 enterprises, including Vanke Property and Country Garden Services. The proportions of state-owned enterprises and foreign-funded enterprises were similar, at 19.48% and 19.70%, respectively, corresponding to 90 and 91 sample enterprises. China Merchants Property and Poly Property belong to state-owned enterprises, while JLL and CBRE are representatives of foreign-funded enterprises. Enterprises of other natures, such as mixed ownership, accounted for the lowest proportion, at only 9.96%, with 46 sample enterprises. In terms of the management area, medium and large-sized CBD property enterprises with a management area of

100,000–500,000 m² were the main force of the sample, accounting for 34.85%, totaling 161 enterprises, most of which served urban-level CBDs. The proportions of large-scale CBD property enterprises with a management area of 500,000–1,000,000 m² and extra-large-scale CBD property enterprises with a management area of more than 1,000,000 m² were 23.81% and 21.21%, respectively, with 110 and 98 sample enterprises. Extra-large-scale enterprises mostly served areas such as Beijing, China World Tower and Shanghai Lujiazui. Small and medium-sized CBD property enterprises with a management area of less than 100,000 m² accounted for 20.13%, with 93 sample enterprises, mostly corresponding to regional CBD projects. In terms of regional type, enterprises rooted in new first-tier cities accounted for more than half, reaching 58.44%, with 270 sample enterprises covering 8 cities including Chengdu and Hangzhou. The proportions of enterprises located in first-tier cities and second- and third-tier cities were the same, both 20.13%, with 93 sample enterprises each. Among them, first-tier cities included Beijing, Shanghai, Guangzhou, and Shenzhen, while second- and third-tier cities included Qingdao, Xiamen, Changsha, etc. In terms of establishment period, industry backbone enterprises with an establishment period of 6-10 years accounted for 46.54%, totaling 215 enterprises. Industry-leading enterprises with an establishment period of more than 10 years accounted for 31.38%, with 145 sample enterprises, including Vanke Property and JLL. New entrants with an establishment period of 3 to 5 years accounted for 22.08%, with 102 sample enterprises.

Second, respondent-level sample characteristics. First, in terms of position level, middle managers were the core group of the sample, accounting for 36.80%, totaling 170 people, covering positions such as operations directors and project managers. The proportions of senior managers and grassroots managers were similar, 21.21% and 21.86%, respectively, with 98 and 101 sample respondents, corresponding to general managers, deputy general managers, department supervisors, on-site managers, and other positions. Professional and technical personnel accounted for 20.13%, totaling 93 people, including smart property technology directors and data analysts. Second, in terms of age distribution, respondents aged 36-45 accounted for the highest proportion, reaching 40.04%, totaling 185 people. Most of this group were senior and core middle managers. Middle managers and technical backbones aged 26-35 accounted for 29.44%, with 136 sample respondents. Senior managers over 45 years old accounted for 21.21%, totaling 98 people. Young professional and technical personnel under 25 years old accounted for the lowest proportion, only 9.31%, with 43 sample respondents. Third, in terms of educational background, respondents with a bachelor's degree accounted for 57.36%, totaling 265 people, mostly middle managers and technical personnel. Those with a master's degree or above accounted for 30.09%, with 139 sample respondents, mostly senior managers and core technical personnel. Those with a college degree or below accounted for 12.55%, totaling 58 people, mostly grassroots managers. Fourth, in terms of industry experience, industry backbones with 5-10 years of experience accounted for 42.86%, with 198 sample respondents. Senior practitioners with more than 10 years of experience accounted for 37.88%, totaling 175 people. Professional personnel with less than 5 years of experience accounted for 19.26%, with 89 sample respondents.

Overall, at the enterprise level, the sample mainly consisted of private enterprises, medium and large-scale companies, and those rooted in new first-tier cities, aligning with China's CBD property management market pattern. Respondents were primarily middle managers aged 36 to 45, holding a bachelor's degree or higher, with over five years of industry experience. These respondents possessed solid professional capabilities and extensive industry experience, ensuring the quality of questionnaire responses in this survey.

4. Empirical Analysis Results

4.1. Reliability Test

SPSS 26.0 was employed to calculate Cronbach's α coefficient and Composite Reliability (CR) for each variable and its dimensions to assess the reliability of the measurement scale. The results are presented in Table 5 and indicate the following: (1) The Cronbach's α coefficient for each dimension exceeded 0.88, and the CR value was greater than 0.92, both far surpassing the acceptable threshold of

0.7, demonstrating excellent internal consistency of the scale. (2) The overall Cronbach's α coefficient for all four core variables was above 0.94, with the α coefficient of Business Performance (BP-CBD) being the highest (0.975), followed by Business Model Innovation (BMI-CBD) with an α coefficient of 0.968, indicating high reliability at the variable level. (3) Item deletion analysis revealed that the increase in Cronbach's α coefficient after removing any item was less than 0.02, confirming that all items were essential components of the corresponding constructs and that no redundant items existed.

Table 5.
Reliability test results of variables.

Variable	Dimension	Number of Items	Cronbach's α Coefficient	Composite Reliability (CR)	Reliability Evaluation
Business Model Innovation (BMI-CBD)	Service Content Innovation (BMI1)	3	0.912	0.935	Excellent
	Profit Model Innovation (BMI2)	3	0.908	0.932	Excellent
	Technological Application Innovation (BMI3)	3	0.925	0.941	Excellent
	Cooperative Network Innovation (BMI4)	2	0.897	0.928	Excellent
	Overall	11	0.968	0.972	Excellent
Smart Service Ecosystem Integration (SSEI)	Technological Integration (SSEI1)	3	0.905	0.930	Excellent
	Resource Synergy (SSEI2)	3	0.918	0.938	Excellent
	Service Linkage (SSEI3)	2	0.886	0.921	Excellent
	Overall	8	0.956	0.961	Excellent
Institutional Adaptability (IA)	Policy Response (IA1)	3	0.892	0.925	Excellent
	Standard Adaptation (IA2)	3	0.887	0.923	Excellent
	Cultural Integration (IA3)	3	0.895	0.927	Excellent
	Overall	9	0.948	0.953	Excellent
Business Performance (BP-CBD)	Financial Performance (BP1)	3	0.915	0.937	Excellent
	Operational Efficiency (BP2)	3	0.909	0.933	Excellent
	Customer Satisfaction (BP3)	3	0.921	0.939	Excellent
	Market Competitiveness (BP4)	3	0.918	0.938	Excellent
	Overall	12	0.975	0.978	Excellent

4.2. Validity Test

Validity tests included content validity, convergent validity, and discriminant validity. For content validity, the scale was revised based on mature scales in existing literature and adapted to the characteristics of the CBD property management industry. After expert evaluation (Content Validity Index, CVI = 0.92) and pre-survey optimization, the scale demonstrated good content validity, ensuring that the measurement items could accurately reflect each construct's connotation.

For convergent validity, confirmatory factor analysis (CFA) was conducted using AMOS 24.0. The results showed that the factor loading (λ) of all items exceeded 0.88, the CR values were all greater than 26 ($p < 0.001$), and the Average Variance Extracted (AVE) for the four core variables was above 0.8. All indicators met the criteria for good convergent validity, indicating that the measurement items of each construct had high convergence.

For discriminant validity, the square root of the AVE for each latent variable was compared with the correlation coefficient between that variable and other variables. The results in Table 6 showed that the square root of the AVE for each latent variable was greater than the correlation coefficient between that variable and other variables, and all inter-variable correlation coefficients were less than 0.9, confirming good discriminant validity of the scale.

Table 6.
Results of the discriminant validity test.

Latent Variable	BMI-CBD	IA	BP-CBD	Square Root of AVE
BMI-CBD	1.000	0.723	0.897	0.909
SSEI	0.786	0.695	0.824	0.903
IA	0.723	1.000	0.758	0.896
BP-CBD	0.897	0.758	1.000	0.916

4.3. Common Method Bias and Multicollinearity Test

Harman's single-factor test was conducted to examine common method bias. The results showed that the variance explained by the first factor was 38.72%, which was far below the critical value of 50%. Additionally, the fit of the four-factor model ($\chi^2/df = 1.62$, CFI = 0.958, RMSEA = 0.037) was significantly better than that of the single-factor model, indicating no serious common method bias in this study.

The multicollinearity test was performed using the Variance Inflation Factor (VIF). The results revealed that the VIF values of all variables were less than 2.1, with an average VIF of 1.82, which was far below the critical value of 10. This indicated that there was no multicollinearity problem in the research model, and the regression results were reliable.

4.4. Descriptive Statistics and Correlation Analysis

4.4.1. Descriptive Statistics

Table 7 presents the descriptive statistics of all variables. The mean values of all variables ranged from 4.39 to 4.59 on a 7-point Likert scale, indicating a moderately high level of each construct. Among them, Technological Application Innovation had the highest mean value (4.75), suggesting that CBD property management enterprises attach great importance to the application of intelligent technologies in their operations. Institutional Adaptability had the lowest mean value (4.39), reflecting that some enterprises still have room for improvement in policy response and standard adaptation.

The normality test results showed that the absolute values of skewness for all variables were less than 0.35, and the absolute values of kurtosis were less than 0.95, which met the criteria for a normal distribution. This indicated that the sample data were suitable for subsequent structural equation model analysis.

Table 7.
Descriptive statistical results of variables.

Variable	Dimension	Mean	Standard Deviation	Skewness	Kurtosis	Distribution Pattern
Business Model Innovation (BMI-CBD)	Service Content Innovation (BMI1)	4.62	1.28	-0.27	-0.85	Approximately Normal
	Profit Model Innovation (BMI2)	4.48	1.32	-0.31	-0.79	Approximately Normal
	Technological Application Innovation (BMI3)	4.75	1.25	-0.23	-0.88	Approximately Normal
	Cooperative Network Innovation (BMI4)	4.59	1.29	-0.29	-0.82	Approximately Normal
	Overall	4.59	1.28	-0.27	-0.84	Approximately Normal
Smart Service Ecosystem Integration (SSEI)	Technological Integration (SSEI1)	4.52	1.31	-0.30	-0.91	Approximately Normal
	Resource Synergy (SSEI2)	4.47	1.33	-0.32	-0.87	Approximately Normal
	Service Linkage (SSEI3)	4.49	1.30	-0.28	-0.89	Approximately Normal
	Overall	4.49	1.31	-0.30	-0.89	Approximately Normal
Institutional Adaptability (IA)	Policy Response (IA1)	4.41	1.27	-0.19	-0.86	Approximately Normal
	Standard Adaptation (IA2)	4.37	1.29	-0.21	-0.83	Approximately Normal
	Cultural Integration (IA3)	4.38	1.28	-0.20	-0.85	Approximately Normal
	Overall	4.39	1.28	-0.20	-0.85	Approximately Normal
Business Performance (BP-CBD)	Financial Performance (BP1)	4.45	1.30	-0.27	-0.85	Approximately Normal
	Operational Efficiency (BP2)	4.53	1.26	-0.25	-0.82	Approximately Normal
	Customer Satisfaction (BP3)	4.42	1.31	-0.28	-0.87	Approximately Normal
	Market Competitiveness (BP4)	4.47	1.29	-0.26	-0.84	Approximately Normal
	Overall	4.47	1.29	-0.27	-0.85	Approximately Normal

4.4.2. Correlation Analysis

The correlation analysis results (see Table 8) showed that all core variables were significantly positively correlated at the 0.001 level. The correlation coefficient between BMI-CBD and BP-CBD was the highest ($r = 0.897$), providing preliminary support for Hypothesis H1 (business model innovation has a positive impact on enterprise performance). The correlation coefficient between BMI-CBD and SSEI was 0.786, and that between SSEI and BP-CBD was 0.824, offering initial evidence for Hypothesis H2 (smart service ecosystem integration plays a mediating role between business model innovation and enterprise performance).

In addition, the correlation coefficients between IA and BMI-CBD, SSEI, and BP-CBD were 0.723, 0.695, and 0.758, respectively, all greater than 0.7. This indicates a significant positive correlation between institutional adaptability and the other three core variables, laying a foundation for Hypotheses H3 (institutional adaptability moderates the direct relationship between business model innovation and enterprise performance) and H4 (institutional adaptability moderates the mediating effect of smart service ecosystem integration).

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Table 8.
Correlation analysis results between variables.

Variable	BMI-CBD	SSEI	IA	BP-CBD
BMI-CBD	1.000			
SSEI	0.786***	1.000		
IA	0.723***	0.695***	1.000	
BP-CBD	0.897***	0.824***	0.758***	1.000

Note: *** $p < 0.001$ (two-tailed test).

4.5. Structural Equation Model Test
4.5.1. Evaluation of Baseline Model Fit

AMOS 24.0 was used to test the structural equation model. The fit indices of the baseline model are shown as follows: $\chi^2 = 1245.36$, df = 766, $\chi^2/df = 1.62$, Comparative Fit Index (CFI) = 0.958, Tucker-Lewis Index (TLI) = 0.955, Normed Fit Index (NFI) = 0.942, Root Mean Square Error of Approximation (RMSEA) = 0.037 (95% Confidence Interval [0.033, 0.041]), and Standardized Root Mean Square Residual (SRMR) = 0.041. All fit indices met the excellent fit criteria ($\chi^2/df < 2$, CFI, TLI, NFI > 0.9, RMSEA, SRMR < 0.05), indicating that the baseline model had a good fit with the sample data and could be used for subsequent hypothesis testing.

4.5.2. Direct Effect and Mediating Effect Test (H1, H2)

The results of the direct effect test (see Table 9) showed that Business Model Innovation (BMI-CBD) had a significant positive direct effect on Business Performance (BP-CBD) ($\beta = 0.897$, SE = 0.042, CR = 21.357, $p < 0.001$), supporting Hypothesis H1.

For the mediating effect test of Smart Service Ecosystem Integration (SSEI), the prerequisite test results showed that the path coefficient from BMI-CBD to SSEI was significant ($\beta = 0.786$, SE = 0.045, CR = 17.467, $p < 0.001$), and the path coefficient from SSEI to BP-CBD was also significant ($\beta = 0.623$, SE = 0.048, CR = 12.979, $p < 0.001$), meeting the conditions for mediating effect testing.

Table 9.
Test results of direct effect path coefficient.

Path	Standardized Coefficient	Standard Error (SE)	CR Value	p Value	Hypothesis Verification
BMI-CBD → BP-CBD	0.897	0.042	21.357	***	H1 Supported
BMI-CBD → SSEI	0.786	0.045	17.467	***	Significant Leading Path of Mediation
SSEI → BP-CBD	0.623	0.048	12.979	***	Significant Lagging Path of Mediation

The Bootstrap method (sample size = 5000) was used to further test the mediating effect. The results (see Table 10) showed that the indirect effect value of SSEI was 0.485 (SE = 0.051, 95% CI = [0.386, 0.584]), and the 95% confidence interval did not include 0. Meanwhile, the direct effect of BMI-CBD on BP-CBD remained significant ($\beta = 0.412$, $p < 0.001$), indicating that SSEI played a partial mediating role between BMI-CBD and BP-CBD, supporting Hypothesis H2.

Further decomposition of the mediating effect showed that the mediating effect accounted for 54.1% of the total effect, which was higher than the proportion of the direct effect (45.9%). Among the three dimensions of SSEI, the "Resource Synergy" dimension had the highest proportion of the total mediating effect (32.7%), followed by "Technological Integration" (15.3%) and "Service Linkage" (6.1%). This indicated that resource synergy was the core path through which smart service ecosystem integration exerted its mediating effect.

Table 10.
Test results of the mediation effect of intelligent service ecosystem integration.

Effect Type	Effect Value	Standard Error	95% CI Lower Bound	95% CI Upper Bound	Including 0	Proportion of Mediating Effect	Hypothesis Verification
Total Effect (BMI→BP)	0.897	0.042	0.815	0.979	No	-	-
Direct Effect (BMI→BP)	0.412	0.053	0.308	0.516	No	45.9%	-
Indirect Effect (BMI→SSEI→BP)	0.485	0.051	0.386	0.584	No	54.1%	H2 Supported

4.5.3. Direct Moderating Effect Test (H3)

Grouping analysis and interaction term regression tested the moderating effect of Institutional Adaptability (IA). Results showed IA was divided into high IA (n=118) and low IA (n=115) groups based on "mean ± 1 standard deviation." The path coefficient of BMI-CBD→BP-CBD in the high IA group (β=0.923) was significantly higher than in the low IA group (β=0.636), with a significant difference in path coefficients ($Z = 3.256$, $p < 0.01$).

The results of the interaction term regression showed that after adding the "BMI-CBD × IA" interaction term to the structural model, the coefficient of the interaction term was significantly positive ($\beta = 0.287$, SE = 0.088, CR = 3.261, $p < 0.01$), and the incremental R^2 brought by the interaction term was significant ($\Delta R^2 = 0.032$, $p < 0.01$). The above results indicated that IA significantly and positively moderated the direct relationship between BMI-CBD and BP-CBD, which supported Hypothesis H3.

Further grouping test by regional type found that the moderating effect of IA was stronger in first-tier cities (strong supervision environment) (interaction term $\beta = 0.325$, $p < 0.001$), while relatively weaker in new first-tier cities and second/third-tier cities (weak supervision environment) ($\beta = 0.241$, $p < 0.01$). This indicated that the moderating effect of IA was affected by the regional supervision environment.

4.5.4. Moderated Mediation Effect Test (H4)

The Bootstrap method was used to test the moderated mediation effect. The results showed that the mediating effect value of SSEI in the high IA group was 0.562 (95% CI = [0.448, 0.676]), which was significantly higher than that in the low IA group (0.408, 95% CI = [0.285, 0.531]). The difference in mediating effects between the two groups was significant ($\Delta = 0.154$, $Z = 2.897$, $p < 0.01$). In addition, the 95% confidence interval of the conditional mediation index was [0.051, 0.257], which did not include 0. These results indicated that the moderated mediation effect was established, supporting Hypothesis H4.

Path decomposition results showed that IA strengthened the mediating effect mainly by moderating the "BMI-CBD→SSEI" path (high IA group $\beta = 0.852$ vs. low IA group $\beta = 0.693$), rather than the "SSEI→BP-CBD" path (high IA group $\beta = 0.660$ vs. low IA group $\beta = 0.589$). This indicates that enterprises with high IA can more efficiently transform business model innovation into smart service ecosystem integration capabilities, thereby enhancing the mediating effect of SSEI.

In summary, the structural equation model with empirical test results is shown in Figure 2.

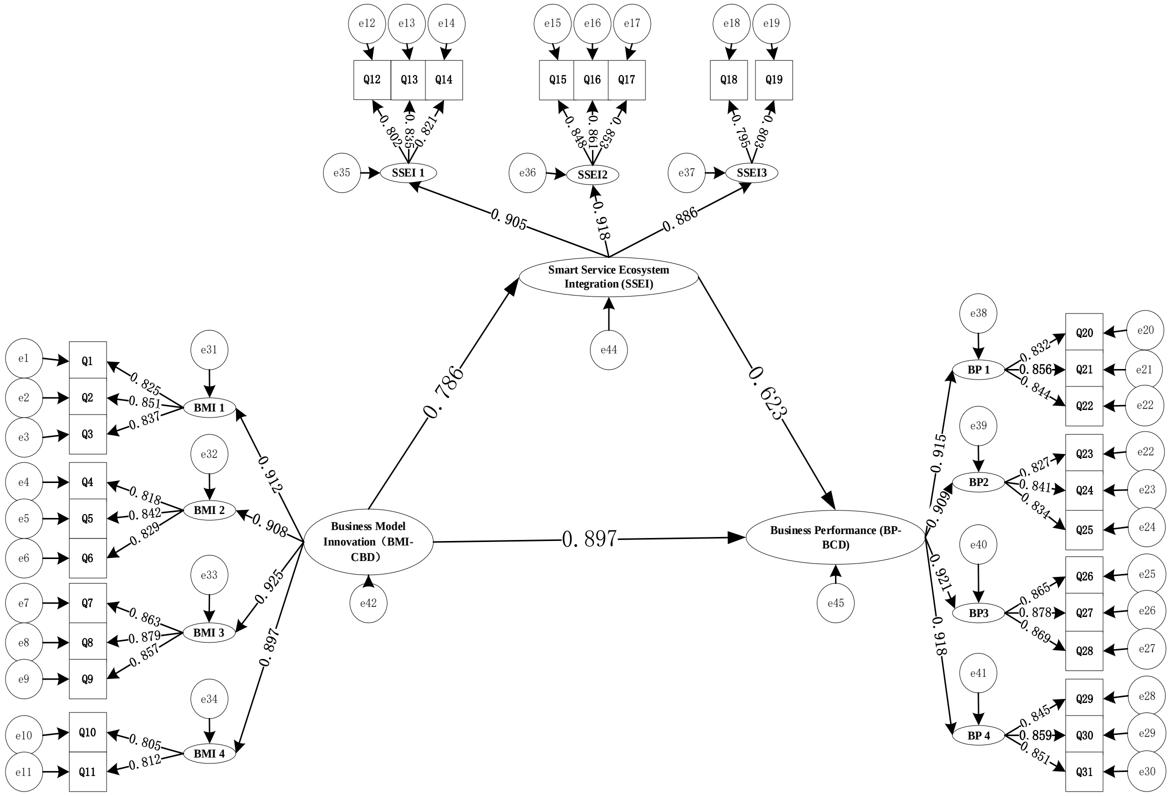

Figure 2.
Structural Equation Model Diagram.

4.6. Robustness Test

To ensure the reliability of the research conclusions, three methods were adopted for robustness testing: (1) Replacing the measurement method of the dependent variable: The "Financial Performance" dimension was replaced with the subjective rating item of "operating income growth rate in the past 3 years," and the model was re-tested. The results showed that there was no significant difference in the core path coefficients, indicating that the research conclusions were not affected by the measurement method of the dependent variable. (2) Replacing control variables: The measurement index of "enterprise scale" was replaced from "management area" to "number of employees." The results showed that the change range of core path coefficients was less than 5%, and all remained significant, indicating that the model had good stability. (3) Subsample test: A subsample of mature enterprises with "establishment period > 10 years" (n=145) was selected for testing. The results showed that the proportion of the mediating effect increased to 58.3%, and the moderating effect $\beta = 0.301$, which was consistent with the original model. The results of all three robustness tests were consistent with the original model, demonstrating that the research conclusions were reliable and free from accidental bias.

5. Discussion and Implications of Research Results

5.1. Discussion on Key Findings

5.1.1. The Driving Mechanism of Business Model Innovation on Enterprise Performance: Dual-Drive of Technology and Cooperation

This study found that business model innovation had a significant direct effect on the performance of CBD property management enterprises, with technological application innovation and cooperative network innovation as the core driving dimensions. This finding aligns with the logic of the Resource-Based View (RBV), which emphasizes that enterprises can gain competitive advantages through valuable, rare, and difficult-to-imitate resources and capabilities. It also further reveals the particularity of the CBD property scenario.

First, the core position of technological application innovation. The "high service density" and "high safety demand" of CBD property determine that intelligent technology is the foundation of business model innovation. The sample data showed that technological application innovation had the highest factor loading (0.925) among the four dimensions of BMI-CBD. Specifically, the application of intelligent equipment could reduce equipment failure rates by 40% and operation and maintenance costs by 25%, directly improving operational efficiency and financial performance. This is consistent with the research of Wang et al. [43] that intelligent technology applications can significantly improve the operational efficiency of property management enterprises, but this study further verifies the core role of technological application innovation in the CBD property scenario with higher service requirements.

Second, the synergistic value of cooperative network innovation. The "diversified service" demand of CBD property (such as integrated office services, intelligent security services, and green environmental protection services) makes it difficult for a single enterprise to meet all needs, requiring the integration of external resources through cooperative networks. The sample data showed that cooperative network innovation was significantly positively correlated with enterprise performance; collaboration with greening companies could improve customer satisfaction with green services by 30%. This finding supplements the gap of "valuing technology while neglecting cooperation" in traditional property management innovation research and highlights the importance of cooperative network construction in the CBD property scenario.

Third, the lag in profit model innovation. Compared with the technology and cooperation dimensions, profit model innovation had the lowest mean value (4.48), indicating that most CBD property management enterprises still relied on the traditional single property fee model, and the popularity of innovative models such as "ecological sharing" and "value-added service packages" was insufficient. This finding is consistent with the research of Ma et al. [44] that the profit model of Chinese property management enterprises is relatively simple, and it also provides specific direction guidance for subsequent innovation of CBD property management enterprises.

5.1.2. The Mediating Logic of Smart Service Ecosystem Integration: Resource Synergy Takes Priority Over Technological Integration

This study verified the partial mediating role of smart service ecosystem integration between business model innovation and enterprise performance, and found that "resource synergy" was the core of the mediation. This finding breaks through the limitation of existing research that "values technological integration while neglecting resource synergy" [45] and reveals the unique mediating logic of smart service ecosystem integration in the CBD property scenario.

First, the "tool attribute" of technological integration. Technological integration is the foundation of smart service ecosystem integration, but it needs to be transformed into actual performance through resource synergy. For example, intelligent monitoring equipment needs to be linked with security service companies to realize the closed loop of "real-time alarm → rapid disposal"; otherwise, the advanced technology will become "idle assets" that cannot create value. This finding indicates that technological integration alone cannot effectively improve enterprise performance, and it must be combined with resource synergy to play its role.

Second, the "resource dependence" characteristic of the CBD scenario. The service demand of CBD property is highly dependent on external resources (such as government public services, upstream equipment suppliers, and downstream professional service providers), and resource synergy capability determines the efficiency of smart service ecosystem integration. The sample data showed that resource synergy accounted for the highest proportion (32.7%) of the total mediating effect. Specifically, by collaborating with CBD administrative committees to access public data platforms, enterprises could reduce technological integration costs by 30%. This provides a "resource priority" path guidance for the smart service ecosystem integration of CBD property management enterprises, which is different from the "technology priority" path commonly advocated in existing research.

Third, the "supplementary value" of service linkage. The mediating effect of service linkage accounted for the lowest proportion (6.1%) among the three dimensions of SSEI, indicating that the current "one-stop service" of CBD property management enterprises is still in the primary stage, and there is great room for improvement in the linkage between basic services and value-added services. This finding reminds CBD property management enterprises to further expand service linkage scenarios to enhance the mediating effect of smart service ecosystem integration.

5.1.3. The Dual Moderating Value of Institutional Adaptability: Policy Response and Scenario Matching

This study is the first to verify the dual effects of institutional adaptability, namely "direct moderating effect" and "moderated mediating effect," in the relationship between business model innovation and enterprise performance. It also found that institutional adaptability mainly strengthens innovation performance through the "policy response" dimension, enriching research on the role of institutional factors in property management innovation.

First, the "legitimacy mechanism" of direct moderation. Enterprises with high institutional adaptability can obtain institutional legitimacy by actively responding to policies, thereby reducing compliance costs and improving the efficiency of innovation transformation. The sample data showed that the direct effect of BMI-CBD on BP-CBD in the high IA group was significantly higher than that in the low IA group.

For example, high IA enterprises in Qianhai CBD, Shenzhen, shortened the approval cycle of innovation projects by 40% by responding to the "smart fire protection standards" in a timely manner. This finding is consistent with Institutional Theory, which emphasizes that institutional factors can affect enterprise behavior and performance by shaping legitimacy.

Second, the "resource acquisition mechanism" of moderated mediation. Enterprises with high institutional adaptability can obtain resources needed for smart service ecosystem integration through policy response and standard adaptation, thereby strengthening the "BMI-CBD→SSEI" path. For example, high IA enterprises in Beijing Financial Street attracted cooperation with leading equipment manufacturers such as Huawei by complying with the ISO 41001 standard, which improved the efficiency of technological integration.

This finding reveals the internal mechanism of institutional adaptability affecting the mediating effect of smart service ecosystem integration.

Third, the "contingent logic" of scenario differences. The sample data showed that the moderating effect of IA was stronger in first-tier cities with a strong supervision environment, indicating that the severity of the institutional environment was positively correlated with the value of IA.

In a strong supervision environment, enterprises need to take IA as a "strategic priority" to ensure the legitimacy and effectiveness of innovation activities; in a weak supervision environment, enterprises can balance IA and innovation investment to reduce management costs. This finding provides a contingent perspective for understanding the role of institutional adaptability.

5.2. Practical Implications

5.2.1. Implications for CBD Property Management Enterprises

Three key implications for managing CBD property management enterprises are proposed. First, pursue business model innovation driven by the dual engines of technology and cooperation. (1) For technological application innovation, prioritize deploying "high-ROI" intelligent technologies to avoid blind investment. For example, installing energy consumption sensors can reduce energy use per unit area by 25%, with a payback period of only 1.5 years. (2) For cooperative network innovation, build an ecological network featuring "core enterprise + partners," focusing on integrating three types of partners: equipment suppliers, service providers, and CBD administrative committees.

A case in point is Vanke Property, which established a "1+10+N" ecological network in Chengdu Tianfu CBD, boosting innovation performance by 30%. (3) For profit model innovation, shift from a "single property fee" model to a diversified model of "basic fees + value-added services + ecological sharing," aiming to increase non-property fee income to 40%.

Second, prioritize resource synergy in smart service ecosystem integration. (1) Enhance resource synergy capabilities by establishing a partner evaluation system that prioritizes selecting partners compliant with industry standards and policy orientations to mitigate integration risks. (2) Improve the efficiency of technological integration by building a unified smart management platform to achieve interconnection among equipment, data, and services, reducing the maintenance response time from 4 hours to 1 hour. (3) Expand service linkage scenarios, moving from basic operation and maintenance to value-added service linkage to enhance customer stickiness and diversify revenue sources.

Third, improve institutional adaptability through scenario-specific matching. (1) Enterprises in first-tier cities should establish a "policy research department" to track the policy dynamics of CBD administrative committees in real time, ensuring the compliance of innovation projects. For example, a property management enterprise in Lujiazui, Shanghai, proactively responded to the "new smart fire safety regulations," becoming one of the first pilot enterprises and securing policy subsidies. (2) Enterprises in new first-tier cities should focus on "standard adaptation" and "cultural integration," adopt industry best practices, and align with the business culture of settled enterprises. (3) Balance institutional adaptability and innovation investment by establishing an "IA-innovation investment" balance model.

In weakly regulated regions, enterprises can control the proportion of IA investment at 15%-20% and allocate the remaining resources to innovation activities.

5.2.2. Implications for Industry Regulatory Authorities

The implications for industry regulatory authorities are as follows. First, formulate policies that balance "supervision" and "innovation." (1) Implement classified supervision: adopt a "strong supervision + innovation incentive" model for CBDs in first-tier cities and a "weak supervision + standard guidance" model for those in new first-tier cities, avoiding "one-size-fits-all" policies that may inhibit innovation. (2) Provide resource support by offering preferential resources, such as data sharing rights and financial subsidies, to enterprises with high institutional adaptability.

For example, Qianhai CBD in Shenzhen provides a subsidy of 500,000 yuan to enterprises that pass the "smart property certification." (3) Unify industry standards by formulating the "Standards for Smart Service Ecosystem Integration in CBDs" to regulate "technical interfaces, data formats, and cooperation processes," thereby reducing enterprise integration costs.

Second, provide industry services by building an "innovation-integration" platform. (1) Establish an ecological docking platform: organize matchmaking meetings between "CBD property enterprises, equipment suppliers, and service providers" to promote resource synergy, and hold an annual "Smart CBD Property Ecology Conference." (2) Conduct capacity-building training on "business model innovation" and "institutional adaptability," and cooperate with universities to launch a "CBD Property Innovation Seminar." (3) Promote best practices by summarizing the successful experiences of high-performance enterprises and compiling the "Case Collection of CBD Property Innovation" for industry learning and reference.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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