

Article

Influencing Factors of Green Smart City Development Under Government–Enterprise Cooperation: An Integrated DEMATEL-ISM-MICMAC Approach

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Highlights

Please indicate how your work links to systems science via your contributions to systems practice, theory, and/or methodology.

- This study conceptualizes green smart city development as an interdependent system in which government enabling conditions and enterprise implementation capabilities jointly shape system performance.
- The integrated DEMATEL-ISM-MICMAC approach reveals causal direction, hierarchical transmission, driving power, and dependence, thereby strengthening the systems analysis of collaborative urban governance.

What are the main findings and/or the implications of the main findings?

- Policy system and funds are the fundamental drivers, while infrastructure and talents transmit institutional and resource support into implementation capacity.
- Technologies and innovation are dependent outcomes, indicating that sustainable green smart city development requires coordinated improvements in institutions, finance, digital foundations, and enterprise capabilities.

Abstract

Green smart city development increasingly depends on cooperation between public authorities and enterprises, yet existing research has not adequately explained how government-side enabling conditions and enterprise-side capabilities are structurally connected. This study identifies the key factors affecting green smart city development from the perspective of government–enterprise cooperation and examines their causal relationships, hierarchical structure, driving power, and dependence. A systematic literature review and Delphi consultation with ten experts from government agencies, enterprises, and universities in China were used to establish a framework of ten factors. The enterprise factors include technologies, innovation, responsibilities, management, and talents, while the government factors include databases, platforms, infrastructure, funds, and policy system. An integrated DEMATEL-ISM-MICMAC approach was then applied to analyze the relationships among these factors. The results show that policy system and funds are the fundamental driving factors, infrastructure and talents serve as key transmission factors, and technologies and innovation are highly connected but mainly dependent on upstream conditions. Responsibilities show relatively weak structural connectivity and become more influential when embedded in formal institutional and managerial mechanisms. This study develops



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a unified analytical framework that links government enabling conditions with enterprise implementation capabilities, clarifies the internal structure of green smart city development, and provides practical guidance for improving policy coordination, financial support, digital foundations, and enterprise capacity in China and other comparable contexts.

Keywords: green smart city; government-enterprise cooperation; influencing factors; DEMATEL; ISM; MICMAC

1. Introduction

Green smart cities integrate the objectives of smart city development and green development [1]. Smart city development emphasizes data-driven governance and the application of digital technologies to enhance the efficiency, accuracy, and responsiveness of urban management. Green development emphasizes low-carbon transition, resource efficiency, ecological protection, and long-term environmental value. A green smart city therefore refers to an urban development model that leverages intelligent technologies to optimize the allocation and operation of urban elements, reduce energy and environmental pressures, and provide a more livable and sustainable urban environment [2]. Through the coordinated use of sensing, communication, and computational capabilities, green smart cities can strengthen comprehensive perception of urban systems, improve collaborative decision-making, and support refined management in areas such as energy, transportation, and environmental governance [3]. Meanwhile, the green orientation ensures that the deployment of technology serves sustainability outcomes rather than technology adoption alone. As a result, green smart cities have become a widely discussed and increasingly implemented pathway to improve urban quality and achieve sustainable development goals in many countries and regions.

The development of green smart cities is a complex socio-technical system project characterized by high investment intensity, long construction and operation cycles, and strong externalities [4]. Governments typically play a leading role by setting development goals, providing institutional safeguards, coordinating departments, and ensuring that public interests such as environmental quality and equitable access to services are protected [5]. At the same time, enterprises often possess key resources that are essential for implementation, including advanced technologies, innovation capacity, project delivery capability, and specialized talents [6]. As a result, government–enterprise cooperation has become a common governance and implementation arrangement for green smart city development [7]. Government–enterprise cooperation can promote cross-departmental coordination, resource integration, and the sharing of data and infrastructure, and it can facilitate the transformation of technological solutions into stable urban services [8]. However, such cooperation also faces practical challenges, including the alignment of objectives, the continuity of financial support, the adequacy of digital foundations, and the effectiveness of policy guidance. Therefore, identifying the key influencing factors of green smart city development under government–enterprise cooperation is important for both theory development and policy design.

Collaborative governance provides a useful theoretical perspective for understanding why cooperation between governments and enterprises is central to green smart city development [9,10]. Complex public problems cannot be effectively addressed by a single actor because authority, resources, knowledge, and implementation capacity are distributed across organizational boundaries. Governments possess regulatory authority, public resources, and responsibility for collective objectives, whereas enterprises provide technological expertise, innovation capability, organizational flexibility, and operational services. The

effectiveness of green smart city development therefore depends not only on the individual capacity of either participant but also on whether their complementary resources are coordinated through stable institutional arrangements, shared objectives, incentive mechanisms, and clearly defined responsibilities. From this perspective, government–enterprise cooperation is not merely a project delivery mechanism. It is the governance structure through which environmental objectives, digital technologies, and urban services are connected [11].

A socio-technical systems perspective further suggests that the outcomes of this cooperation cannot be explained by institutional arrangements or technological capabilities in isolation [12,13]. Green smart city development involves the interaction of policy rules, financial resources, databases, digital platforms, infrastructure, organizational management, professional talents, technological applications, innovation activities, and responsibility mechanisms. These elements are mutually dependent and occupy different structural positions. Some factors establish the institutional and resource foundations of cooperation. Some transmit these conditions into organizational and technological capabilities. Others mainly reflect implementation outcomes that depend on the prior formation of enabling conditions. The central analytical task is therefore not limited to identifying which factors are important. It also requires clarification of how the factors influence one another, how influence is transmitted across different levels, and which factors possess stronger driving power or dependence.

Existing research has generated extensive knowledge on green smart cities. Conceptual studies have examined the integration of digital intelligence, environmental sustainability, and urban governance [14]. Evaluation studies have developed indicator systems to assess smartness, greenness, livability, resilience, and sustainability performance [15,16]. Other studies have investigated policy support, digital infrastructure, platform construction, technological innovation, financial investment, and low-carbon development pathways [17,18]. These studies provide an important foundation for understanding the composition and performance of green smart cities. However, government–enterprise cooperation is commonly treated as a contextual condition or implementation arrangement rather than as the central perspective for identifying and organizing influencing factors [19,20]. Government-related conditions and enterprise-related capabilities are often examined separately or presented as parallel determinants. This separation limits understanding of how government enabling conditions are converted into enterprise implementation capacity and how enterprise capabilities translate public objectives into sustainable urban services. It also makes it difficult to distinguish fundamental drivers, transmission conditions, and outcome-oriented factors.

To address this gap, this study examines the influencing factors of green smart city development from the perspective of government–enterprise cooperation. A systematic literature review and Delphi consultation are used to establish a factor system that incorporates both the government enabling conditions and enterprise implementation capabilities. The enterprise factors include technologies, innovation, responsibilities, management, and talents. The government factors include databases, platforms, infrastructure, funds, and policy system. These factors reflect the functional division within the cooperative process. Government factors provide institutional direction, resource guarantees, and public digital foundations. Enterprise factors determine whether these conditions can be transformed into technological applications, organizational coordination, innovation outcomes, and sustained operational performance. Responsibilities are included because enterprise participation in green smart city projects involves not only commercial objectives but also environmental obligations, service reliability, and public value creation.

The structural relationships among these factors are examined through an integrated DEMATEL, ISM, and MICMAC approach. DEMATEL measures the strength and direction of direct and indirect influences and distinguishes factors that mainly exert influence

from those that mainly receive influence [21]. ISM organizes significant relationships into a hierarchical structure and reveals how influence is transmitted from fundamental conditions to intermediate capabilities and implementation outcomes [22]. MICMAC evaluates the driving power and dependence of each factor and clarifies its structural role within the system [23]. The integration of these methods moves the analysis beyond factor identification and importance ranking. It enables the study to determine which factors initiate systemic change, which factors connect different levels of the system, and which factors depend more strongly on upstream institutional, financial, digital, and organizational support.

This study contributes to existing research in three respects. First, it places government–enterprise cooperation at the center of the analysis and connects government enabling conditions with enterprise implementation capabilities in a unified framework. This perspective extends green smart city research beyond separate discussions of public policy, infrastructure, enterprise technology, and innovation, and explains development as a coordinated governance process involving complementary actors and resources. Second, it reveals the causal relationships, hierarchical positions, transmission paths, driving power, and dependence among the identified factors. By distinguishing fundamental drivers, intermediate transmission conditions, and implementation outcomes, the study provides a more systematic explanation of how green smart city development progresses and offers a clearer basis for sequencing policy and managerial interventions. Third, the analysis draws on the Chinese context, where governments play an important role in strategic planning, resource coordination, policy design, and digital infrastructure construction, while enterprises undertake technology development, system integration, project delivery, and operational services [24]. Based on the identified relationships, the study proposes constructive recommendations for policy coordination, financial continuity, digital foundations, talent development, enterprise management, technological innovation, and responsibility mechanisms. These recommendations respond to the practical needs of green smart city development in China and provide useful references for cities seeking to strengthen cooperation between public authorities and enterprises.

2. Research Design and Methodology

The research flow chart is shown in Figure 1. This study follows a two-stage design. The first stage identifies and refines the influencing factors of green smart city development through literature retrieval and Delphi consultation. The second stage analyzes the structural relationships among the identified factors by integrating DEMATEL, ISM, and MICMAC. DEMATEL is used to calculate causality and centrality, ISM is used to construct the hierarchical structure, and MICMAC is used to classify factors according to driving power and dependence. This design enables the study to move from factor identification to structural interpretation and then to policy and managerial implications.

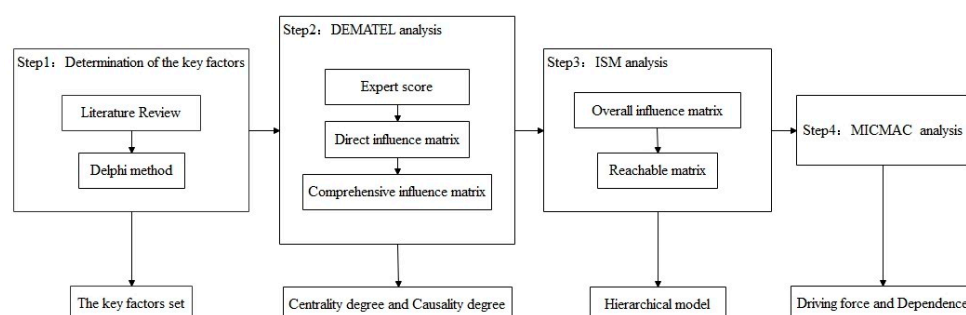


Figure 1. The research flow chart.

2.1. Literature Retrieval and Delphi-Based Factor Identification

To retrieve the relevant literature, this study used the Web of Science Core Collection and Scopus databases to identify studies related to green smart city development and government–enterprise cooperation. Search terms included “green smart city”, “smart city”, “green development”, “government”, “enterprise”, and “cooperation”, combined with “AND” and “OR”. The search yielded 312 articles from Scopus and 254 articles from the Web of Science Core Collection. After screening the titles, abstracts, keywords, and full texts for relevance to green smart city development and cooperative governance, 18 preliminary factors were identified. The enterprise-side factors included technologies, innovation, responsibilities, management, talents, culture, scale, strategy, and asset status. The government-side factors included databases, platforms, infrastructure, funds, policy system, laws, regulatory investment, regulatory efforts, and local protection.

The screening process followed the logic of relevance, conceptual clarity, and operational applicability. Articles were first checked for whether they directly addressed green development, smart city construction, digital governance, low-carbon urban transition, or public–private cooperation. Studies that only discussed general urbanization or isolated technological applications without a clear connection to green smart city development were excluded. The remaining literature was then reviewed to extract factors that appeared repeatedly across conceptual, empirical, and policy-oriented studies. To avoid an excessively broad and weakly actionable list, factors with similar meanings were merged, while factors that were difficult to observe or difficult for either government or enterprises to influence were removed. This process resulted in an initial pool that covered both enterprise capability conditions and government enabling conditions, which provided a balanced basis for subsequent expert consultation.

Ten China-based experts were purposively selected from government agencies, enterprises, and universities, as shown in Table 1. Each had more than five years of relevant experience, and the panel combined policy design, project implementation, and academic evaluation perspectives. The same panel subsequently completed the directed influence assessment after the factor set and definitions had been finalized. The two stages were separated by purpose and instruction: the Delphi rounds addressed factor inclusion and conceptual boundaries, whereas the DEMATEL task addressed the dominant direct influence of each finalized factor on every other factor. The pairwise matrices were completed independently and anonymized before aggregation, thereby avoiding a negotiated group matrix while maintaining conceptual continuity across the two stages.

Table 1. Profile of the experts.

Expert	Age	Gender	Organization	Position	Experience (Years)
E1	50	Male	Government	Director	18
E2	47	Female	Government	Director	16
E3	44	Female	Government	Deputy director	13
E4	44	Male	Enterprise	Manager	15
E5	47	Female	Enterprise	Manager	17
E6	36	Female	Enterprise	Deputy manager	9
E7	43	Female	University	Professor	14
E8	47	Male	University	Professor	18
E9	49	Female	University	Professor	20
E10	52	Male	University	Professor	22

The Delphi consultation comprised two documented rounds. In Round 1, the experts independently assessed the 18 preliminary factors in terms of conceptual independence, relevance to government–enterprise cooperation, and operational applicability in planning and implementation. They could recommend retention, deletion, merger, renaming, or

clarification. The research team consolidated the comments and documented the reason for each change. In Round 2, the revised factor list, definitions, and reduction record were returned to the panel for confirmation. Consensus was defined as the absence of any further request for deletion, merger, or renaming, and all ten experts confirmed the final ten-factor system. The criterion was procedural because the task concerned the conceptual adequacy and boundaries of heterogeneous factors rather than the internal consistency of interchangeable scale items. The refinement from the 18 preliminary factors to the 10 final factors is summarized in Table 2. The final factors are shown in Table 3.

Table 2. Refinement from preliminary factors to final factors.

Preliminary Factor	Treatment	Reason
Culture	Merged into management	Culture is reflected in organizational routines, internal coordination, and managerial practices.
Scale	Removed	Enterprise size is an important background condition but is less actionable as a cooperative governance lever.
Strategy	Merged into management	Strategy overlaps with implementation planning, organizational coordination, and managerial decision-making.
Asset status	Removed	Asset status describes firm resource endowment but is not a stable system-level factor in the cooperation mechanism.
Laws	Merged into policy system	Legal rules are treated as part of the broader institutional and policy framework.
Regulatory investment	Merged into funds	Regulatory investment reflects public financial input and therefore belongs to the funds factor.
Regulatory efforts	Merged into policy system	Regulatory efforts are embodied in standards, supervision, assessment, and policy implementation.
Local protection	Removed	Local protection is a context-specific institutional distortion rather than a general enabling factor.

Table 3. Final influencing factors of green smart city development.

Category	Influencing Factors	Reference	Code
Enterprise	Technologies	[25–27]	A1
	Innovation	[28–30]	A2
	Responsibilities	[31–34]	A3
	Management	[35–37]	A4
	Talents	[38–40]	A5
Government	Databases	[41–43]	B1
	Platforms	[44–46]	B2
	Infrastructure	[47–49]	B3
	Funds	[50–52]	B4
	Policy system	[53–55]	B5

2.2. DEMATEL Analysis

DEMATEL is a multi-criteria decision-making method used to reveal the strength and direction of influence among factors in a complex system. In this study, DEMATEL is used to construct the comprehensive influence matrix and to calculate the centrality and causality of each factor. ISM is then used to transform the influence relationships obtained

from DEMATEL into a hierarchical structure, thereby identifying surface, transitional, deep, and root-level factors. MICMAC analysis further classifies the factors according to driving power and dependence on the basis of the reachable matrix. The integrated DEMATEL-ISM-MICMAC approach is suitable for this study because green smart city development under government–enterprise cooperation involves multiple interdependent factors whose causal direction and hierarchical position cannot be sufficiently explained by a simple list of determinants. This integrated approach has been widely applied in studies of complex systems, such as constraints on IoT adoption in off-site construction [56], AI-enabled elderly care resource decision-making [57], and sustainable development initiatives in agri-food industries [58].

(1) Construct the direct influence matrix

Based on the selected factors, this study designed a questionnaire (Appendix A) and invited experts to evaluate the influence of each factor on the others. The influence degree was divided into five levels: very high, high, moderate, low and none, which were coded as 4, 3, 2, 1 and 0. According to the a_{ij} values provided by the expert, the direct influence matrix X is obtained, as shown in Equation (1). The ten anonymized matrices were averaged to obtain the direct influence matrix X . Relation-specific standard deviations were retained to show dispersion, and the individual matrices and dispersion matrix are reported in Supplementary Materials.

$$X = \begin{bmatrix} 0 & a_{12} & \dots & a_{1n} \\ a_{21} & 0 & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & 0 \end{bmatrix} \quad (1)$$

where $a_{ij} = \frac{\sum_{p=1}^m a_{ij}^p}{m}$, a_{ij}^p captures the p th expert's assessment of how strongly a_i influences a_j . Here, m denotes the number of experts and n denotes the number of factors.

(2) Normalize the direct influence matrix

The direct influence matrix is normalized by the maximum row sum of X , as shown in Equation (2). This standardization places the direct influence values on a comparable scale and enables the total relation matrix to be calculated from the accumulated influence series.

$$D = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n a_{ij}} \times X = \begin{bmatrix} 0 & d_{12} & \dots & d_{1n} \\ d_{21} & 0 & \dots & d_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \dots & 0 \end{bmatrix} \quad (2)$$

(3) Obtain the comprehensive influence matrix

Based on the normalized direct influence matrix D , the direct influence and indirect influence of each influencing factor are accumulated to calculate the comprehensive influence matrix T , as shown in Equation (3).

$$T = \lim_{q \rightarrow \infty} (D + D^2 + D^3 + \dots + D^q) = D \times (I - D)^{-1} = \begin{bmatrix} t_{11} & \dots & t_{1n} \\ \vdots & \ddots & \vdots \\ t_{n1} & \dots & t_{nn} \end{bmatrix} \quad (3)$$

(4) Centrality and causality analysis

The influencing degree f_i and influenced degree e_i are calculated using Equations (4) and (5). On this basis, the centrality degree M_i and causality degree N_i of each factor are

obtained using Equations (6) and (7). Centrality reflects the overall structural connectedness of a factor within the system, while causality indicates whether a factor mainly acts as a cause factor or an effect factor. A positive causality value means that the factor exerts stronger influence on other factors than it receives from them, whereas a negative value means that the factor is more strongly affected by other factors.

$$f_i = \sum_{j=1}^n t_{ij} \quad i = 1, 2, \dots, n \quad (4)$$

$$e_i = \sum_{j=1}^n t_{ji} \quad i = 1, 2, \dots, n \quad (5)$$

$$M_i = f_i + e_i \quad i = 1, 2, \dots, n \quad (6)$$

$$N_i = f_i - e_i \quad i = 1, 2, \dots, n \quad (7)$$

2.3. ISM Analysis

(1) Construct the overall influence matrix

The overall influence matrix H can be obtained, as shown in Equation (8).

$$H = T + I = \begin{bmatrix} h_{11} & \dots & h_{1n} \\ \vdots & \ddots & \vdots \\ h_{n1} & \dots & h_{nn} \end{bmatrix} \quad (8)$$

Here, T is the comprehensive influence matrix and I is the identity matrix.

(2) Construct the reachable matrix

To remove weak relationships and obtain a parsimonious binary structure, a threshold λ is applied to the overall influence matrix H . The mean and population standard deviation are calculated from all n^2 entries of the comprehensive influence matrix T . The main model uses $\lambda = \text{mean}(T) + \text{SD}(T)$, while $\lambda = \text{mean}(T)$ and $\lambda = \text{mean}(T) + 0.5\text{SD}(T)$ are used for sensitivity analysis. The reachable matrix K is obtained using Equations (9) and (10).

$$k_{ij} = 1, h_{ij} \geq \lambda \quad (i, j = 1, 2, \dots, n) \quad (9)$$

$$k_{ij} = 0, h_{ij} < \lambda \quad (i, j = 1, 2, \dots, n) \quad (10)$$

(3) Build the hierarchical model

Let U_k denote the set of factors that have not yet been assigned to a level at iteration k . Equations (11) and (12) define the reachable set $R_k(i)$ and antecedent set $S_k(i)$ within the submatrix induced by U_k . The factors satisfying Equation (13) constitute level L_k . After a level is identified, its factors are removed from U_k , and the reachable and antecedent sets are recalculated for the remaining factors. The procedure continues until every factor has been assigned to a level.

$$R_k(i) = \{a_j \in U_k \mid k_{ij} = 1\} \quad (11)$$

$$S_k(i) = \{a_j \in U_k \mid k_{ji} = 1\} \quad (12)$$

$$L_k = \{a_i \in U_k \mid R_k(i) \cap S_k(i) = R_k(i)\} \quad (13)$$

2.4. MICMAC Analysis

The driving power and dependence values in MICMAC analysis can be calculated with Equations (14) and (15), respectively, based on the reachable matrix K .

$$B_i = \sum_{j=1}^n k_{ij}, \quad i = 1, 2, \dots, n \quad (14)$$

$$C_i = \sum_{j=1}^n k_{ji}, \quad i = 1, 2, \dots, n \quad (15)$$

where B_i is the driving power of factor i and C_i is the dependence of factor i .

2.5. Validity and Robustness Considerations

Validity was assessed across factor identification, expert rating, and structural modeling. The factor pool was derived from a systematic literature review and refined through two Delphi rounds involving government, enterprise, and university experts. For the DEMATEL assessment, the ten individual matrices were retained rather than reporting only their average. Across the 90 directed off-diagonal relationships, the tie-corrected Kendall coefficient of concordance was $W = 0.811$ ($\chi^2 = 722.211$, $df = 89$, $p < 0.001$), and the two-way random-effects single-measure intraclass correlation was $ICC(2,1) = 0.869$. The mean relation-specific standard deviation was 0.444, with a range of 0.316–0.527. These results indicate substantial convergence while preserving visible variation among expert judgments.

Cronbach's alpha was not used because the 90 directed relationships are distinct judgment objects rather than interchangeable items measuring a single latent construct. Kendall's W , ICC , and relation-specific dispersion are therefore more appropriate indicators of inter-rater reliability. The participation of the same panel in both stages supports continuity in factor interpretation but can also create confirmation bias. To reduce this risk, the factor list and definitions were fixed before directed influence scoring, the two stages used different instructions, and the matrices were completed independently without group negotiation. These procedures improve task separation while leaving the institutional and cognitive boundaries of expert judgment explicit.

Threshold robustness was examined under three settings: $\lambda = \text{mean}(T) = 0.061$, $\lambda = \text{mean}(T) + 0.5SD(T) = 0.094$, and $\lambda = \text{mean}(T) + SD(T) = 0.126$. The policy system-funds-infrastructure/talents root and transmission sequence remained unchanged, and technologies and innovation remained surface outcomes. Responsibilities shifted between the shallow and surface levels but remained in the low-driving and low-dependence region. The main model uses $\lambda = \text{mean}(T) + SD(T)$, which produces the clearest parsimonious hierarchy; the sensitivity results are reported alongside the main analysis so that borderline links are not treated as invariant.

3. Explanation of Influencing Factors

3.1. Enterprise-Side Factors

To reflect the cooperative nature of green smart city development, this study conceptualizes enterprise-side factors as implementation capabilities that transform public digital foundations, policy incentives, and funding conditions into green smart applications and long-term operational performance. These factors are not isolated enterprise resources. They respectively function as solution carriers, upgrading capabilities, legitimacy mechanisms, coordination mechanisms, and human-capital foundations within government–enterprise cooperation. Their inclusion in the structural model is therefore based not only on their conceptual relevance to green smart city development, but also on their ability to transmit, absorb, or respond to government-side enabling conditions.

(1) Technologies

Technologies represent the enterprise-side solution carrier in green smart city development. Enterprises provide and integrate digital technologies such as cloud computing, the IoT, big data, artificial intelligence, blockchain, and green technologies related to energy saving and renewable energy [25]. These technologies support intelligent sensing, data processing, environmental monitoring, energy management, green buildings, green travel, and low-carbon industrial applications [26]. In government–enterprise cooperation, technologies convert public data, platforms, and infrastructure into concrete urban applications rather than functioning as a stand-alone resource. They can also generate operational feedback for platform optimization, data utilization, management improvement, and policy standard adjustment, but these feedback effects are usually weaker than the enabling effects produced by policy, funding, infrastructure, and data conditions [27].

(2) Innovation

Innovation represents the enterprise-side upgrading capability that enables technologies, products, services, and management models to evolve with changing urban needs [28]. In green smart city projects, innovation supports low-pollution, low-consumption, and high-value technological solutions, and it helps enterprises improve the efficiency of energy use, transportation management, green travel services, and pollution control [29]. Its function is to transform technological capacity into new application scenarios and continuously improve the adaptability of green smart city services. At the same time, innovation depends on access to public data, open platforms, sufficient funding, and clear policy signals. For this reason, innovation may feed back into technology upgrading and platform application, but it remains strongly shaped by institutional and resource conditions [30].

(3) Responsibilities

Responsibilities reflect the legitimacy and accountability mechanism of enterprises in government–enterprise cooperation. Green smart city development is not only a technical or commercial activity; it also involves public value, environmental protection, equitable service provision, and long-term urban sustainability [31]. Enterprises may pursue economic returns within legal and contractual boundaries, but their participation in green smart city projects also requires responsibility for environmental performance, resource use, service reliability, and social outcomes [32]. The functional role of responsibilities is therefore to align enterprise behavior with public goals and strengthen the legitimacy of cooperative projects [33]. However, responsibility becomes structurally influential only when it is embedded in policy rules, contracts, disclosure requirements, performance evaluation, and platform governance mechanisms [34].

(4) Management

Management represents the enterprise-side coordination mechanism that links technology supply with project delivery and long-term operation. Green smart city projects usually require cross-departmental collaboration, customized technical solutions, continuous service maintenance, and coordination with government departments [35]. Effective management improves response speed, delivery quality, internal incentive alignment, and interdepartmental information sharing [36]. It also helps integrate R&D, production, finance, marketing, and operation teams so that technological solutions can be adapted to public-sector requirements and green development goals [37]. In the structural system, management is both influenced by upstream policy, funding, data, and talent conditions and directly affects how enterprise technologies and innovation are translated into practical implementation performance.

(5) Talents

Talents represent the human-capital foundation for technology absorption, system integration, innovation, and continuous operation. Green smart city development requires professionals who understand digital technologies, green technologies, urban governance, project management, and cross-sector collaboration [38]. A stronger human-resource base enables enterprises to absorb public data resources, participate in platform construction, respond to technical standards, and improve solution design and service maintenance [39]. Talents also shape the speed and direction of enterprise innovation by providing knowledge storage, practical experience, and organizational learning capacity [40]. In government–enterprise cooperation, talents function as a transmission factor: they connect institutional and digital enabling conditions with enterprise management, technological application, and innovation output.

3.2. Government-Side Factors

(1) Databases

Databases represent the public data foundation of green smart city development. Government departments usually hold large amounts of administrative, environmental, transportation, energy, and public-service data, which can support monitoring, forecasting, decision-making, and service optimization [41]. In government–enterprise cooperation, databases provide the information resources through which enterprises develop intelligent applications, optimize energy systems, support environmental governance, and improve operational efficiency [42]. Their functional role is not limited to data storage; they also determine whether technological solutions can be built on reliable, shareable, and analyzable information. When data resources are fragmented or inaccessible, enterprise technologies and innovation are difficult to scale across urban scenarios [43].

(2) Platforms

Platforms function as application integration and service deployment carriers. Green smart city platforms integrate data, algorithms, applications, and services across government departments, enterprises, and users [44]. They support data processing, sharing, mining, search, visualization, and auxiliary decision-making, thereby allowing different actors to access and use urban information in coordinated ways [45]. In government–enterprise cooperation, platforms connect public governance needs with enterprise technical solutions. They reduce repeated construction, improve interoperability, and provide the operational environment in which technologies and innovation can be deployed for energy conservation, low-carbon living, environmental protection, and public service improvement [46].

(3) Infrastructure

Infrastructure represents the physical–digital support condition for green smart city development. Compared with traditional urban facilities, green smart city infrastructure emphasizes informatization, cleanliness, low energy consumption, and intelligent operation [47]. It includes information infrastructure, sensing facilities, communication networks, intelligent buildings, green facilities, and other systems that support data collection, transmission, integration, and application [48]. During planning, construction, and operation, tools such as BIM and GIS can improve facility quality, refined management, and subsequent service capability [49]. In the structural system, infrastructure serves as a middle-level transmission condition because it converts policy and funding support into usable databases, platforms, and enterprise application environments.

(4) Funds

Funds represent the resource guarantee mechanism for green smart city development. Green smart city projects require continuous investment in infrastructure upgrading, data integration, platform operation, technology R&D, pilot demonstration, and long-term maintenance [50]. Government financial support, subsidies, and related investment mechanisms can reduce enterprise participation risk and stimulate digital and intelligent transformation [51]. The functional role of funds is therefore to provide continuity and resource stability for cooperative projects. Without sufficient and sustained funding, technological innovation, platform operation, infrastructure maintenance, and enterprise participation may become fragmented or short-lived [52].

(5) Policy system

Policy system represents the institutional rule-setting mechanism of green smart city development. It provides technical standards, planning requirements, operational guarantees, information security rules, coordination mechanisms, assessment systems, and resource allocation principles [53]. A sound policy system clarifies the boundary of government–enterprise cooperation, defines responsibilities and risk allocation, standardizes data and platform construction, and guides resources toward green and intelligent industries [54]. It is foundational because it shapes the direction, legitimacy, stability, and accountability of all other factors. By establishing standards, incentives, and evaluation mechanisms, policy system provides the institutional conditions under which funds, infrastructure, databases, platforms, talents, management, technologies, and innovation can operate coherently [55].

4. Structural Relationship Results

4.1. Centrality and Causality Analysis

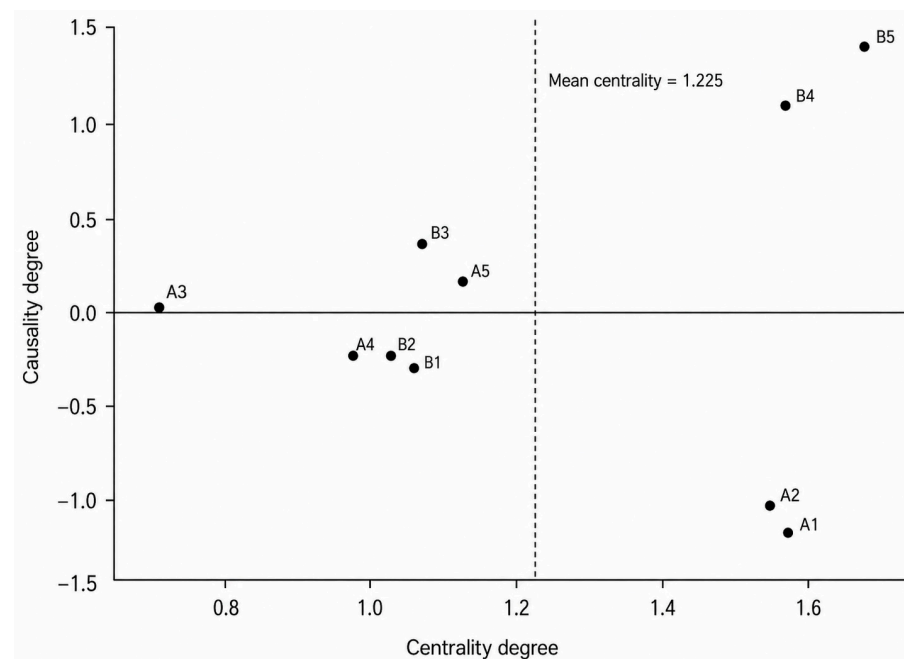
The DEMATEL method is used to generate the causality and centrality of each factor. To aggregate the independent judgments of the ten experts, their ratings were averaged to obtain the direct influence matrix X , as shown in Table 4. The comprehensive influence matrix T is shown in Table 5. The causality and centrality results are presented in Figure 2. The horizontal line at $N_i = 0$ separates cause and effect factors, and the dashed vertical line denotes the mean centrality (1.225).

Table 4. Direct influence matrix.

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
A1	0	0.6	0.2	0.5	0.4	0.5	0.5	0.2	0.1	0.2
A2	0.8	0	0.2	0.6	0.5	0.5	0.5	0.2	0.2	0.3
A3	2.5	2.4	0	0.3	0.2	0.2	0.2	0.1	0.1	0.2
A4	2.6	2.3	0.4	0	0.4	0.3	0.3	0.2	0.1	0.2
A5	3.1	3.2	0.5	3.2	0	0.4	0.4	0.3	0.2	0.2
B1	2.7	2.5	0.2	0.4	0.3	0	0.8	0.2	0.1	0.1
B2	2.6	2.4	0.2	0.4	0.3	0.8	0	0.2	0.1	0.1
B3	2.3	2.4	0.3	0.4	0.4	2.9	2.9	0	0.3	0.2
B4	3.1	3.2	1.9	2.2	3.1	2.8	2.7	2.8	0	0.4
B5	2.6	2.5	2.3	2.2	2.9	2.7	2.9	2.8	3.2	0

Table 5. Comprehensive influence matrix.

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
A1	0.017	0.040	0.012	0.028	0.021	0.027	0.027	0.012	0.007	0.010
A2	0.053	0.020	0.013	0.034	0.027	0.029	0.029	0.013	0.011	0.014
A3	0.119	0.114	0.005	0.022	0.016	0.018	0.018	0.009	0.008	0.011
A4	0.127	0.113	0.022	0.012	0.025	0.023	0.023	0.013	0.008	0.012
A5	0.167	0.168	0.029	0.147	0.014	0.033	0.033	0.020	0.014	0.014
B1	0.132	0.122	0.013	0.028	0.021	0.011	0.043	0.013	0.007	0.008
B2	0.128	0.118	0.013	0.028	0.020	0.043	0.011	0.013	0.007	0.008
B3	0.145	0.145	0.021	0.035	0.030	0.137	0.137	0.009	0.018	0.014
B4	0.231	0.230	0.096	0.134	0.151	0.156	0.152	0.130	0.012	0.027
B5	0.236	0.227	0.122	0.147	0.159	0.168	0.176	0.145	0.143	0.013

**Figure 2.** Centrality–Causality degree distribution.

Policy system (B5) has the highest centrality (1.667), followed by technologies (A1, 1.555), funds (B4, 1.552), and innovation (A2, 1.538). Centrality indicates structural connectedness rather than independent causal dominance. The combination of high centrality and positive causality for B5 and B4 identifies them as upstream drivers, whereas the high centrality but negative causality of A1 and A2 indicates that technologies and innovation are prominent implementation outcomes shaped by multiple upstream conditions.

The causality results identify policy system (B5, 1.406), funds (B4, 1.083), infrastructure (B3, 0.312), and talents (A5, 0.154) as cause factors. Responsibilities are nearly balanced (A3, −0.006), while technologies (A1, −1.154), innovation (A2, −1.055), management (A4, −0.236), databases (B1, −0.245), and platforms (B2, −0.259) are effect factors. This pattern distinguishes foundational institutional and resource conditions from transmission mechanisms and outcome-oriented enterprise capabilities.

The direct and indirect effects therefore form an ordered enabling process. Policy rules and financial commitment create the conditions for infrastructure and human-capital development; infrastructure and talents support the construction and use of databases, platforms, management routines, technologies, and innovation. Responsibilities do not operate as an independent upstream force in the present structure, but their near-zero

causality indicates that they can become consequential when embedded in the institutional mechanisms that govern the other relationships.

4.2. Hierarchical Model

The ISM hierarchy was constructed from the reachable matrix under $\lambda = \text{mean}(T) + \text{SD}(T) = 0.126$. The overall influence matrix H is shown in Table 6, and the reachable matrix K is shown in Table 7. The factors are divided into five different levels. The hierarchical model is obtained by connecting the influencing factors whose interrelationships are greater than the threshold in the comprehensive influence matrix, as shown in Figure 3.

Table 6. Overall influence matrix.

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
A1	1.017	0.040	0.012	0.028	0.021	0.027	0.027	0.012	0.007	0.010
A2	0.053	1.020	0.013	0.034	0.027	0.029	0.029	0.013	0.011	0.014
A3	0.119	0.114	1.005	0.022	0.016	0.018	0.018	0.009	0.008	0.011
A4	0.127	0.113	0.022	1.012	0.025	0.023	0.023	0.013	0.008	0.012
A5	0.167	0.168	0.029	0.147	1.014	0.033	0.033	0.020	0.014	0.014
B1	0.132	0.122	0.013	0.028	0.021	1.011	0.043	0.013	0.007	0.008
B2	0.128	0.118	0.013	0.028	0.020	0.043	1.011	0.013	0.007	0.008
B3	0.145	0.145	0.021	0.035	0.030	0.137	0.137	1.009	0.018	0.014
B4	0.231	0.230	0.096	0.134	0.151	0.156	0.152	0.130	1.012	0.027
B5	0.236	0.227	0.122	0.147	0.159	0.168	0.176	0.145	0.143	1.013

Table 7. Reachable matrix.

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
A1	1	0	0	0	0	0	0	0	0	0
A2	0	1	0	0	0	0	0	0	0	0
A3	0	0	1	0	0	0	0	0	0	0
A4	1	0	0	1	0	0	0	0	0	0
A5	1	1	0	1	1	0	0	0	0	0
B1	1	0	0	0	0	1	0	0	0	0
B2	1	0	0	0	0	0	1	0	0	0
B3	1	1	0	0	0	1	1	1	0	0
B4	1	1	0	1	1	1	1	1	1	0
B5	1	1	0	1	1	1	1	1	1	1

Under the main threshold, technologies (A1), innovation (A2), and responsibilities (A3) form the surface level; management (A4), databases (B1), and platforms (B2) form the shallow level; talents (A5) and infrastructure (B3) form the middle transmission level; funds (B4) occupy the deep level; and policy system (B5) forms the root level. At the two lower thresholds, A3 moves to the shallow level, while the remaining root, transmission, and outcome sequence is unchanged. The stable positions of B5, B4, B3, A5, A1, and A2 support the central interpretation, whereas the position of A3 should be understood as threshold-sensitive at the periphery of the hierarchy.

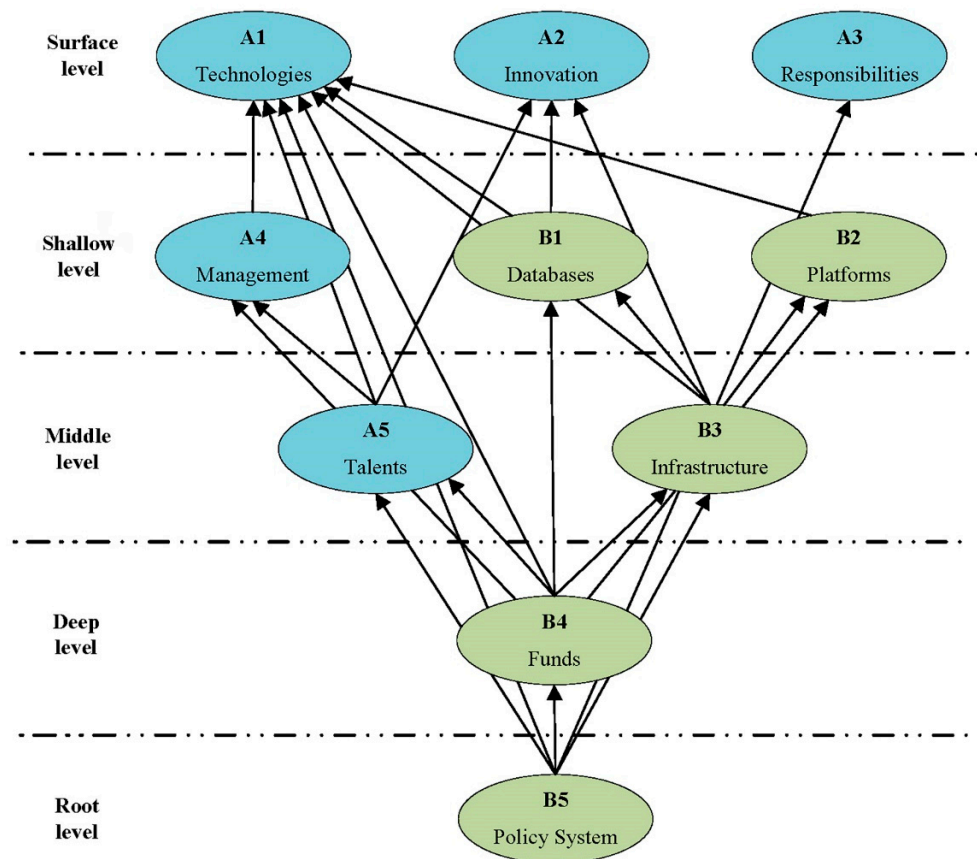


Figure 3. The hierarchical model of various factors. Blue nodes represent enterprise-side factors, whereas green nodes represent government-side factors.

4.3. Driving Power and Dependence Analysis

MICMAC driving power is the row sum of the reachable matrix and dependence is the corresponding column sum, as shown in Figure 4. Under the main threshold, the mean of the ten row sums and the ten column sums is 3.5; this arithmetic mean is used as the common boundary separating high and low driving power and dependence. The resulting coordinates are A1 (1,8), A2 (1,5), A3 (1,1), A4 (2,4), A5 (4,3), B1 (2,4), B2 (2,4), B3 (5,3), B4 (8,2), and B5 (9,1).

Policy system (B5), funds (B4), infrastructure (B3), and talents (A5) occupy the driving quadrant. Their positions align with the ISM hierarchy: B5 and B4 provide root and deep institutional-resource support, while B3 and A5 transmit these conditions into operational capability. The B5 coordinate is (9,1), calculated directly from the row and column sums of Table 7.

No factor appears in the linkage quadrant under the main threshold. This does not imply an absence of feedback in real projects; it indicates that none of the ten factors simultaneously has above-mean driving power and above-mean dependence in the transitive structure retained by the model. Feedback processes such as policy learning from enterprise implementation require longitudinal evidence and are not inferred from the static expert matrix.

Responsibilities (A3) occupy the autonomous quadrant with driving power and dependence both equal to 1. The result is stable across the three MICMAC threshold settings even though A3 changes ISM level. Autonomous status should therefore be interpreted as limited structural embedding within the modeled influence network, not as low ethical or practical importance. Responsibility can exert stronger systemic effects when it is converted into enforceable contractual, disclosure, procurement, and performance requirements.

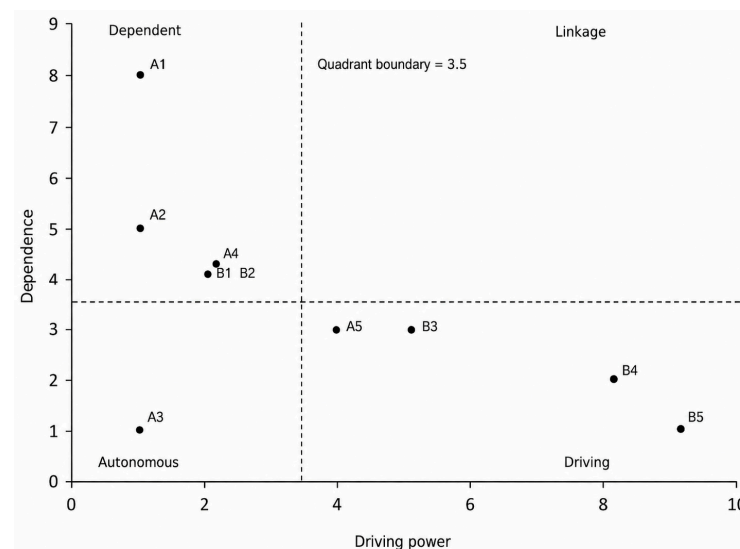


Figure 4. Driving power–dependence degree distribution of various factors. The dashed lines represent the mean driving power and dependence value of 3.5 and define the four MICMAC quadrants.

Technologies (A1), innovation (A2), management (A4), databases (B1), and platforms (B2) are dependent factors. Their positions show that visible technical and operational outputs rely on the upstream policy, funding, infrastructure, and human-capital configuration. The dependent classification of databases and platforms likewise indicates conditionality rather than marginality: their effectiveness depends on standards, investment continuity, infrastructure interoperability, and organizational capacity.

4.4. Integrated Interpretation of Results

Taken together, DEMATEL, ISM, and MICMAC identify a coherent policy-finance-transmission-outcome architecture. DEMATEL distinguishes B5 and B4 as the strongest causal factors and A1 and A2 as highly connected effect factors. ISM places B5 and B4 at the root and deep levels, B3 and A5 in the transmission layer, and the remaining factors near implementation. MICMAC confirms the high driving power of B5, B4, B3, and A5 and the dependence of A1, A2, A4, B1, and B2. The three methods therefore converge on the same structural interpretation rather than producing separate classifications.

The resulting mechanism is sequential but not mechanically linear. Institutional rules and financial commitment establish credible cooperation; infrastructure and talent translate those guarantees into digital and organizational capacity; databases, platforms, management, technologies, and innovation materialize as implementation functions and outcomes. Responsibilities cross this sequence as an accountability condition whose influence depends on whether public-value commitments are embedded in the institutions governing resource allocation, data use, procurement, and performance evaluation.

5. Discussion

5.1. Institutional and Financial Foundations of Collaborative Governance

The root positions of policy system (B5) and funds (B4) are consistent with collaborative governance research, which treats institutional design, role clarity, coordination rules, and credible resource commitment as preconditions for sustained cross-sector cooperation [59]. The results add an explicit causal ordering to this literature. Policy system is not simply another supportive condition; it establishes the rules through which standards, data rights, risk allocation, evaluation criteria, and interorganizational responsibilities are defined. Funds occupy the next deepest level because institutional commitments acquire operational credibility only when sufficient resources are available for infrastructure construction,

platform operation, technology development, and long-term maintenance. The combined position of B5 and B4 therefore shows that cooperation begins with an institutional-resource foundation rather than with the direct deployment of technology.

This interpretation is also compatible with empirical studies showing that smart city policies in China can improve green total-factor productivity, green economic efficiency, environmental performance, and green technological innovation [60]. Those studies identify whether policy interventions generate beneficial outcomes at the city level. The present findings complement that evidence by explaining a possible internal pathway: policy rules and financial commitment first shape infrastructure, data, platforms, talent, and organizational capacity, and these conditions subsequently support technological application and innovation. In this way, the structural model connects observed policy effects with the cooperative mechanisms through which public action can influence enterprise behavior and project implementation.

The findings also qualify interpretations that treat government support as an external background variable. In the Chinese setting, public authorities often combine strategic planning, fiscal support, infrastructure coordination, data stewardship, and standard setting, while enterprises provide technical systems, innovation, and operational services [61]. The analysis indicates that these public functions influence not only the immediate project environment but also the formation and deployment of enterprise capabilities. This extends collaborative governance research by identifying a sequence through which public coordination is converted into private implementation capacity. It also creates a basis for comparison: in other institutional settings, private finance, regulatory intermediaries, civic organizations, or market competition may occupy some of the transmission roles performed here by government-coordinated resources.

5.2. Socio-Technical Transmission from Public Foundations to Enterprise Outcomes

Infrastructure (B3) and talents (A5) form the principal transmission layer, supporting the socio-technical proposition that urban transformation depends on the joint development of technical and organizational subsystems. Digital infrastructure connects sensing, communication, data processing, and service delivery and therefore converts policy and financial commitment into an operational environment [62]. Talents perform a parallel organizational function by enabling technology absorption, interdisciplinary coordination, maintenance, and adaptation. Their middle-level position shows why institutional support does not translate automatically into green smart outcomes: it must pass through physical–digital systems and human capabilities that can integrate public objectives with enterprise implementation.

The dependent positions of databases (B1) and platforms (B2) provide a more differentiated interpretation than studies that describe data hubs and digital platforms as self-sufficient drivers of smart city development [63]. The present results confirm their functional importance, because they connect public information resources with enterprise applications and urban services. However, their low driving power indicates that data and platforms become effective only when upstream rules clarify ownership, access, security, and standardization and when funding, infrastructure, and management sustain interoperability and operation. The findings therefore distinguish practical indispensability from causal autonomy: databases and platforms are central interfaces in the socio-technical system, but their performance depends on broader institutional and resource arrangements.

Technologies (A1) and innovation (A2) are highly connected yet strongly outcome-oriented. This finding complements technology-centered smart city research, which emphasizes the potential of the Internet of Things, artificial intelligence, digital platforms, and green technological innovation to improve urban sustainability [64]. It does not reduce

the importance of technology. Instead, it shows that technological importance is different from causal primacy. Advanced applications produce sustained benefits only when data are accessible, platforms are interoperable, infrastructure is reliable, standards are clear, investment is continuous, and organizations possess the talent and management capacity required for integration. This helps explain why technology-first projects may generate isolated pilots or duplicated systems when their institutional and organizational foundations remain fragmented.

The relative positions of talents and management further clarify the enterprise side of the cooperation mechanism. Research on innovation ecosystems, absorptive capacity, and management support shows that human capital, organizational learning, and internal coordination shape the conversion of digital resources into green innovation and service performance [65]. The stronger driving position of talents suggests that knowledge and absorptive capacity support several downstream functions, including managerial coordination, technology use, and innovation. Management is located closer to implementation because it organizes delivery, maintenance, incentives, and interaction with government agencies. Together, these factors show that enterprise capability is not a single resource but a sequence in which human capital supports organizational coordination and technical application.

5.3. Responsibilities as an Institutionally Embedded Accountability Mechanism

The autonomous position of responsibilities (A3) requires a distinction between normative importance and structural connectedness. Corporate responsibility research associates environmental and social commitments with legitimacy, stakeholder engagement, risk management, and public acceptance in smart and sustainable city projects [66,67]. These functions remain important, but they do not necessarily generate broad causal influence across a network dominated by policy, finance, infrastructure, data, technology, and organizational capability. In the expert assessments, responsibilities have their strongest direct relationships with technologies and innovation and weaker connections with most other factors, resulting in near-zero causality and low driving power and dependence.

This result refines, rather than contradicts, the responsibility literature. Responsibility becomes structurally influential when general commitments are translated into formal governance arrangements. Research on government supervision and city-enterprise collaboration similarly indicates that enterprise conduct is shaped by monitoring, incentives, reputation, contractual obligations, and institutional rules [68,69]. In green smart city projects, responsibility can be operationalized through environmental procurement criteria, service-quality clauses, data-ethics requirements, public-value indicators, disclosure obligations, and post-project evaluation. Once embedded in these mechanisms, responsibility can influence resource allocation, technical design, platform governance, and operational behavior; without such embedding, it may remain normatively important but weakly connected to the main implementation chain.

The robustness results support this interpretation. A3 shifts between the shallow and surface ISM levels when the threshold changes, but it remains in the autonomous MICMAC quadrant and its causality stays close to zero. Its precise hierarchical location is therefore sensitive to peripheral links, whereas its limited driving-dependence profile is stable. The appropriate conclusion is not that responsibility is unimportant, but that its influence depends on whether cooperative institutions connect it to standards, contracts, funding conditions, data practices, and performance assessment.

This interpretation also highlights the reciprocal dimension of government–enterprise cooperation. Governments create the institutional channels through which responsibility can shape project design and operation, whereas enterprises provide operational knowledge and performance information that can support policy learning and the refinement

of standards. The dominant structure identified by the model runs from institutional and resource capacity toward enterprise outcomes, but accountability mechanisms can strengthen feedback across this structure. Embedding responsibility in enforceable and measurable governance instruments is therefore more consequential than treating it as a separate moral commitment.

6. Conclusions

6.1. Main Findings

This study examined the influencing factors of green smart city development under government–enterprise cooperation and clarified their causal relationships, hierarchical structure, and driving-dependence characteristics. Based on a systematic literature review and the Delphi method, ten key factors were identified from both enterprise and government dimensions. An integrated DEMATEL-ISM-MICMAC approach was then used to reveal their structural roles within the cooperative system. The results show that policy system and funds are the root and deep drivers; infrastructure and talents transmit institutional and resource support into digital and organizational capacity; databases, platforms, management, technologies, and innovation operate closer to implementation; and responsibilities acquire broader influence when embedded in formal governance instruments. The core sequence remains stable under three-threshold settings. These findings demonstrate that green smart city development depends on the coordinated progression from institutional rules and financial commitment to socio-technical foundations and enterprise implementation rather than on technology adoption alone. The results are grounded in the Chinese context and provide a basis for comparative examination in other institutional settings.

6.2. Contributions and Implications

First, the study advances green smart city research by adopting government–enterprise cooperation as the central analytical perspective. Existing studies have generated extensive knowledge about smart technologies, green performance, public policy, and enterprise capability, but these elements are often examined separately. By integrating five government-side and five enterprise-side factors within one framework, the analysis shows that green smart city construction is an interorganizational process in which public rules, finance, data, and infrastructure shape the conditions under which enterprise management, talent, technology, innovation, and responsibility can operate. This perspective provides a more complete explanation of how public and private capacities jointly influence urban green transformation.

Second, the study provides a structural explanation of the relationships among the influencing factors. The integration of DEMATEL, ISM, and MICMAC does more than identify important factors: it reveals causal direction, hierarchical levels, transmission paths, driving power, and dependence. The resulting policy-finance-transmission-implementation sequence distinguishes root drivers from intermediate conditions and outcome-oriented capabilities. The disclosure of individual matrices, Kendall's W, ICC, relation-specific dispersion, and three-threshold sensitivity analysis further strengthens the transparency of the analytical chain and shows which conclusions are structurally stable.

Third, the China-based findings generate practical implications for green smart city construction. The results suggest that policy coherence and credible funding should be established before large-scale technical deployment; infrastructure, data interoperability, and human-capital development should then be strengthened; and enterprise management, technology, and innovation should be expanded within a stable institutional environment. Responsibility should be incorporated through procurement, contracts, disclosure, data governance, and performance evaluation. Although implementation arrangements differ

across cities, this sequenced approach offers a constructive reference for other contexts seeking to coordinate public governance and enterprise participation while avoiding fragmented investment, duplicated platforms, and isolated technology projects.

6.3. Limitations and Future Research

Several limitations should be acknowledged. First, DEMATEL-ISM-MICMAC relies on expert judgment, and subjective interpretation cannot be completely eliminated even when experts score independently. The study reduces this concern through a two-round Delphi process, disclosure of the ten anonymized matrices, Kendall's W, ICC, relation-specific dispersion, and threshold sensitivity analysis. Future research can further test the identified relationships by combining expert assessment with larger surveys of public officials and enterprise participants, administrative or project-performance data, and structural equation modeling.

Second, the analysis provides a cross-sectional representation of the relationships among the ten factors. It identifies the dominant causal structure but does not directly capture how policy, funding, infrastructure, organizational capability, and technological innovation evolve through feedback over time. Longitudinal case studies, repeated expert assessments, and system dynamics simulations could examine temporal change, policy learning, and the co-evolution of government and enterprise capabilities.

Third, the expert panel and empirical interpretation are situated in China, where government planning, public investment, data coordination, and enterprise implementation have distinctive institutional features. The framework may therefore operate differently under alternative fiscal systems, regulatory arrangements, market structures, or forms of public participation. Comparative studies across cities and countries can evaluate the stability of the hierarchy and identify context-dependent paths. Such extensions would clarify the boundary conditions of the present findings and broaden their relevance to diverse green smart city governance settings.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/systems14080955/s1>, Table S1: Factor framework; Table S2: Rating scale; Table S3: Anonymized expert profile; Table S4: Refinement from the preliminary factors to the final factor set; Tables S5-1 to S5-10: Individual rating matrices of experts E1 to E10; Table S6: Averaged direct influence matrix X; Table S7: Sample standard deviation matrix of expert ratings; Table S8: Inter-rater agreement and reliability statistics; Table S9: Comprehensive influence matrix T; Table S10: Centrality and causality results; Table S11: Reachable matrix K at the main threshold; Table S12: MICMAC driving power, dependence, and classification; Table S13: Threshold sensitivity analysis using retained non-diagonal links.

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Institutional Review Board Statement: Ethical review and approval were waived for this study due to its minimal-risk organizational and academic research nature, and institutional exemption confirmation was provided by Tianjin Normal University.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study. Participants were informed about the purpose of the discussions and the intended academic use of the data.

Data Availability Statement: The original data presented in the study are included in the article and its Supplementary Materials; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

DEMATEL	Decision-Making Trial and Evaluation Laboratory
ISM	Interpretive Structural Modeling
MICMAC	Cross-Impact Matrix Multiplication Applied to Classification
SD	standard deviation

Appendix A

Questionnaire on the influencing factors of green smart city development based on government–enterprise cooperation.

Dear experts, thank you for taking the time to participate in this questionnaire. The main purpose of this questionnaire is to study the influencing factors of green smart city development based on government–enterprise cooperation. Each empty box in Table A1 asks you to compare two factors at a time (i.e., pairwise comparisons). The degree of impact is divided into five levels: very high, high, medium, low, and none, with corresponding scores of 4, 3, 2, 1, and 0. The codes of each factor are shown in Table A2.

Table A1. Scoring table.

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
A1										
A2										
A3										
A4										
A5										
B1										
B2										
B3										
B4										
B5										

Table A2. Symbol description.

Category	Influencing Factors	Code
Enterprise	Technologies	A1
	Innovation	A2
	Responsibilities	A3
	Management	A4
	Talents	A5
Government	Databases	B1
	Platforms	B2
	Infrastructure	B3
	Funds	B4
	Policy system	B5

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