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Analysis of the Influencing Factors of the Success of Metro Commercial Development Projects based on Structural Equation Modeling

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Abstract

To strengthen the control of key points of projects, enhance management capabilities, effectively guide project planning and operation, and promote the implementation and sustainable development of metro commercial development projects, a structural equation theoretical model of the success of metro commercial development projects was established, with four latent variables: government governance, market governance, social governance, and project cooperation process, and 19 observed variables. Through a questionnaire survey of the "Metro e-Station" project in Tianjin and using the AMOS software for validity, reliability analysis, and path testing, it was found after model revision that social governance has the greatest impact on the success of metro commercial development projects, followed by market governance and government governance, while the direct impact of the project cooperation process is not significant. Analysis of the observed variables revealed that supervision and evaluation, operation management, and supervision and review are more prominent factors affecting the success of metro commercial development projects.

Keywords

Metro Commercial Development; Multi-center Governance; Project Success; SEM Model.

1. Introduction

During the "14th Five-Year Plan" period, China is vigorously promoting the construction of a strong transportation nation. As a key part of urban rail transit, the importance of subways is increasing day by day. By the end of 2024, the total mileage of subway lines in many cities has continued to expand and extend, ranking first in the world. Against this backdrop, Metro commercial development has become a key issue in urban development and is deeply integrated into multi-dimensional strategic layouts. Metro commercial development is an economic activity that relies on the space resources of rail transit stations and along the line to realize the transformation of passenger flow value through the construction and operation of commercial facilities, and its essence is the spatial reconstruction of transportation resources to economic resources[1].Typical cases include: Shenzhen Gangxia North Hub integrates "rail + commerce + culture" to activate consumer scenarios; Chengdu Lu Xiao TOD project intensively uses land to create a convenient life circle; Shanghai Xujiahui subway cover complex promotes the integration of production and city; Guangzhou Tianhe City Hub applies green technology to highlight ecological benefits; and Beijing Lize Business District subway station integrates innovative applications to shape a smart paradigm. However, existing research is still insufficient in key aspects such as the balance of multiple stakeholders and the sustainable development of projects.

The theory of key success factors originated in the field of enterprise management and has gradually developed and expanded across industries. In recent years, how to successfully

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implement and promote subway commercial development projects has become an important research direction. Renne analyzed the success and failure cases of six TOD community projects in China and pointed out that financial support, site development and construction,and the relationships between different stakeholders are the keys to the success of TOD projects[2]. Younes identified the key success factors of research projects by combining document analysis and fuzzy network analysis, and further[3] explored the interactions and influence directions between these factors. Wang Yan started from the hierarchical goals of each stage of the project and the core stakeholders, used the DEMATEL method to analyze the 24 key success factors identified for urban rail transit TOD projects in terms of their interrelationships and paths, and finally defined the factors as three roles based on their positions in the hierarchical model: (1) Direct factors: project profitability and public satisfaction; (2) Linkage factors: integrated operation mechanism, clear development entities and dominant rights, good product and service quality, revenue distribution mechanism, incentive mechanism, and the guiding role of rail transit on passenger flow; (3) Fundamental factors: government policy support, complete laws and regulations, and the level of professional institutions and talents[4]. Zhang Yuyu et al. identified 33 success influencing factors for urban rail transit PPP projects through reviewing literature and analyzing multiple domestic and international typical cases, screened out 31 key factors through questionnaires, and used ISM analysis to determine their mechanisms of action and put forward management suggestions[5]. Feng Yahong conducted an in-depth analysis of the implementation process of 28 PPP projects in China to explore the key elements for their successful operation. The study found that a sound PPP institutional environment and system architecture, a complete financial system, and the government's adherence to the spirit of contract are the core points to ensure the successful operation of PPP projects[6]. Qian Yideng et al. used a cutting-edge multidisciplinary research paradigm to combine big data statistics with case analysis to determine the key factors for the implementation of sponge city PPP projects, and further used the analytic hierarchy process - decision laboratory method (AHP-DEMATEL) to analyze big data to determine the overall correlation of each key factor and identify the key implementation factors[7].

The development of subway commerce involves many complex and critical dimensions, from the integration and utilization of station planning and surrounding land resources in the early stage, to the innovation of financing and investment models and risk control in the construction process, and then to the rational layout of commercial formats and the deep integration with urban functions in the later operation stage. Each link faces many challenges. Therefore, it is necessary to explore the key influencing factors of project success and strengthen the analysis and research of relevant factors to provide practical guidance for ongoing or under-construction subway commercial projects and help projects break through obstacles and successfully land and advance.

2. Establishing the Structural Equation Model

Structural equation modeling is a statistical method for analyzing the relationships between variables based on the covariance matrix of variables and is an important tool for multivariate data analysis[8]. In the empirical research on the influencing factors of subway commercial development, traditional statistical methods are more commonly used, such as the analytic hierarchy process often used to determine the weights of various indicators. However, SEM has significant advantages. It not only integrates the data measurement and analysis links but also effectively quantifies indicators that traditional methods find difficult to handle, making up for the shortcomings of single indicators that cannot fully express the deeper meanings of variables. Importantly, SEM can replace the analytic hierarchy process to determine indicator weights, minimizing the interference of subjective factors and improving the accuracy of the results.

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2.1. Evaluation Index System

Under the multi-center governance theory, the one-dimensional governance model often has governance limitations and is prone to governance failure. To achieve the goal of "good governance" of public affairs, the governance of different subjects often depends on the cooperation and complementarity of other governance subjects[9]. Some scholars have critically compared the "multi-center governance" theory with the Chinese governance discourse system - the "social comprehensive management" theory and concluded that the latter is a governance model that has been empirically explored and is in line with China's national conditions, and summarized its connotation as "party leadership, government responsibility, social coordination, public participation, and legal protection." Specifically, compared with the Western "multi-center governance," China's "social comprehensive management" has five characteristics: the diversification and centralization of governance subjects, the concretization and differentiation of governance objects, the formation and institutionalization of governance theories, and the diversification of governance tools and the richness of governance methods[10].

The multi-center governance theory focuses on the key significance of multiple subjects in participation, governance, and order construction, which is in line with the characteristics of multi-party participation management of subway commercial development projects. Macroscopically, it advocates the coordination of multiple governance subjects such as the state, the market, society, and individuals, and microscopically focuses on specific governance practice fields. Given that subway commercial development projects have long cooperation periods, large investments, and complex risks, the participating parties need to build a formal, transparent, and clear cooperation framework in the early stage. From the analysis of the governance level structure, subway commercial development projects can be roughly divided into two major levels of external governance and internal governance. The internal governance is the project cooperation process, and the external governance dimension is further subdivided into three sub-dimensions: government governance, social governance, and market governance. Referring to relevant literature, the evaluation index system of subway commercial development project success under the multi-center governance perspective was constructed based on the existing evaluation indexes after adjustment and revision, as shown in Figure 1.

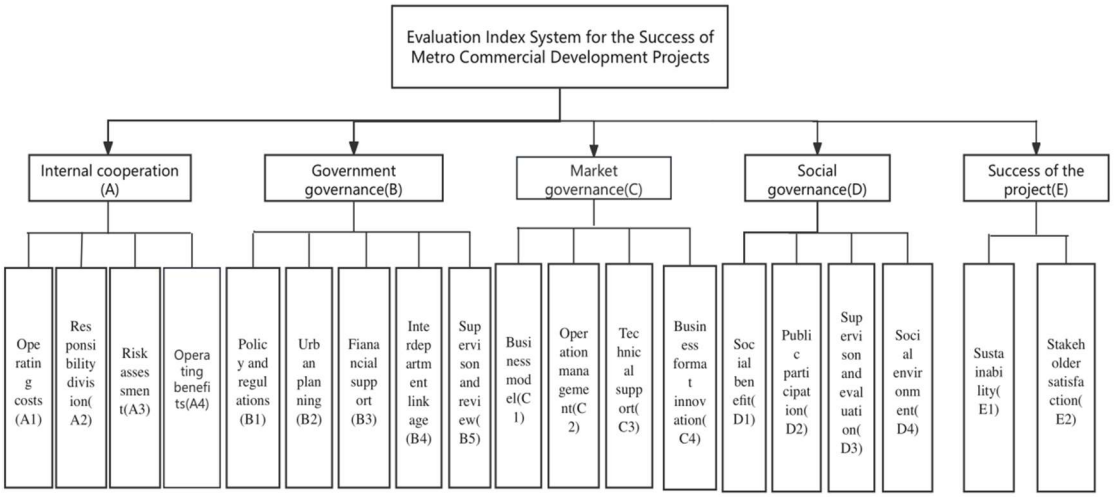

Figure 1. Evaluation index system of subway commercial development project success

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Internal cooperation process: Accurate and reliable cost-benefit assessment is the theoretical basis for the government and social capital parties to determine profit points and judge future earnings[11]. Therefore, operating costs (A1) focus on the costs and control of project implementation; operating benefits (A4) measure the results of commercial operations from financial and non-financial perspectives. Responsibility division (A2) emphasizes the clarity and performance of the responsibilities of each participant and internal entity; risk assessment (A3) is committed to identifying, analyzing, and responding to various potential risks. In terms of government governance, policy and regulations (B1) involve the perfection and implementation of relevant policies and laws; urban planning (B2) is related to the compatibility of the project with the overall urban layout; financial support (B3) reflects the government's financial support and methods; interdepartmental linkage (B4) examines the collaborative efficiency of government departments; supervision and review (B5) aims to ensure the compliance and orderliness of each link of the project. In the market governance dimension, business model (C1) focuses on its adaptability and innovation; operation management (C2) focuses on the standardization of daily operations and service quality; technical support (C3) emphasizes the role of information technology in improving operations; business format innovation (C4) pays attention to the introduction of new commercial forms and their competitiveness. In social governance, social benefits (D1) measure the positive contributions of the project to social development; public participation (D2) values the extent and effectiveness of public opinion expression and supervision; supervision and evaluation (D3) emphasize the strength of social-level supervision and its role in project improvement; and the social environment (D4) considers the support and integration of the project's social environment.

2.2. Model Hypotheses

Based on the above analysis, a multi-center governance perspective model for the success of metro commercial development projects was established, with the following hypotheses:

H1: Government governance and market governance have a significant positive correlation.

H2: Social governance and government governance have a significant positive correlation.

H3: Market governance and social governance have a significant positive correlation.

H4: Government governance has a significant positive impact on the internal collaboration process.

H5: Market governance has a significant positive impact on the internal collaboration process.

H6: Social governance has a significant positive impact on the internal collaboration process.

H7: Government governance has a significant positive impact on the success of metro commercial development projects.

H8: Market governance has a significant positive impact on the success of metro commercial development projects.

H9: Social governance has a significant positive impact on the success of metro commercial development projects.

H10: The internal collaboration process has a significant positive impact on the success of metro commercial development projects.

3. Research Analysis

3.1. Questionnaire Design and Data Sources

The questionnaire was divided into two parts: a survey of basic personal information and a survey of factors influencing metro commercial development. The first part collected basic information about the respondents, such as the type of work unit, project experience, and years

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of work or research. The second part, based on a literature analysis, used a Likert 5-point scale to quantify respondents' subjective attitudes toward various influencing factors. The scale options included "very important," "relatively important," "neutral," "less important," and "unimportant," corresponding to 5, 4, 3, 2, and 1 points, respectively. Higher scores indicated a higher degree of influence.

The questionnaire was distributed both in paper form and online. Paper questionnaires were distributed through staff at JinGui Commercial Management Co., Ltd., and undergraduate and graduate students. Online questionnaires were created using the Questionnaire Star platform and sent to teachers and students in the field of urban rail transit, as well as departments and units directly related to metro commercial development in Tianjin. To ensure the validity of the questionnaire, explanations of the connotation of metro commercial development success and the meanings of various influencing factors were provided via phone, email, face-to-face meetings, and WeChat groups. A total of 378 questionnaires were distributed, with 333 returned, yielding a response rate of 88%. After excluding 33 invalid questionnaires (incomplete or repetitive answers), 300 valid questionnaires were obtained, with an effective response rate of 79.3%.

3.2. Data Analysis

Using AMOS software for data reliability analysis, the Cronbach's α coefficients for the project collaboration process, government governance, market governance, social governance, and the success of metro commercial development projects were 0.869, 0.895, 0.876, 0.847, 0.734, and 0.905, respectively. All scales in the questionnaire exceeded 0.7, indicating high data reliability. The validity analysis results showed that the KMO value was 0.894, and the Bartlett's sphericity test result was significant (P = 0.000***), indicating that the variables were correlated, the factor analysis was effective, and the data were suitable for further analysis.

3.3. Model Testing

This study used the maximum likelihood method to calculate the model, primarily using AMOS 22.0 software to test the constructed structural equation model's fit. The overall fit test and basic parameter fit test were conducted.

(1) Overall Fit Test

Using AMOS 23.0 software to calculate the sample data, the corresponding goodness-of-fit values were obtained, as shown in Table 1. The table shows that the RMR fit of the constructed structural equation model was 0.106 > 0.05, which did not meet the standard, indicating that some content needed to be revised.

Table 1. Fit Index Results Calculation Table

Common Indicators	χ2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI	TLI
Judgment Criteria	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9	>0.9
Value	1.644	0.926	0.046	0.106	0.968	0.923	0.962	0.962
Other indicators	AGFI	IFI	PGFI	PNFI	PCFI	SRMR	RMSEA 90% CI	
Judgment Criteria	>0.9	>0.9	>0.5	>0.5	>0.5	<0.1	-	
Value	0.903	0.968	0.707	0.783	0.821	0.070	0.036 ~ 0.057	

(2) Basic Parameter Fit Test

From the factor loading coefficient table, it can be seen that all measurement items of the factors were significant at the level, rejecting the null hypothesis. The standard loading coefficients were all greater than 0.6, indicating sufficient variance explanation rates. Additionally, the average variance extracted (AVE) values for the internal collaboration process, government

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governance, market governance, and social governance were 0.63, 0.632, 0.638, and 0.585, respectively, all greater than 0.5. The composite reliability (CR) values were 0.871, 0.896, 0.876, and 0.849, respectively, all greater than 0.7, indicating excellent extraction of measurement indicators within the factors, as shown in Table 2.

Table 2. Basic parameter fitting table

Factor	Variable	Non-Stadardized Loading Coefficient	Standardized Loading Coefficient	z	S.E.	P	AVE	CR
Internal Collaboration Process	1. business cost	1	0.73	-	-	-	0.63	0.871
	2.division of responsibilities	1.212	0.817	13.337	0.091	0.000***		
	3.risk assessment	1.235	0.842	13.678	0.09	0.000***		
	4.operating effectiveness	1.168	0.776	12.708	0.092	0.000***		
Government Governance	1.policies and regulations	1	0.798	-	-	-	0.632	0.896
	2.urban planning	0.926	0.778	14.5	0.064	0.000***		
	3.financial support	0.977	0.789	14.752	0.066	0.000***		
	4.linkage among departments	0.951	0.798	14.967	0.064	0.000***		
	5.supervision and examination	0.992	0.812	15.3	0.065	0.000***		
Financial Support	1.investment mode	1	0.788	-	-	-	0.638	0.876
	2.operation management	1.003	0.807	14.442	0.069	0.000***		
	3.technical support	1.003	0.799	14.279	0.07	0.000***		
	4.interactive partner	0.998	0.802	14.343	0.07	0.000***		

Note: ***, **, * represent significance levels of 1%, 5%, and 10%, respectively.

3.4. Model Revision

Using the modification index to revise the model, the revision process and corresponding model fit indices are shown in Table 3. The comparison of model fit indices before and after revision shows that the overall fit of the model has significantly improved. The chi-square to degrees of freedom ratio (χ^2/df) decreased from 1.644 to 1.389, indicating a better fit (values less than 3 are ideal). Additionally, the Goodness of Fit Index (GFI) increased from 0.926 to 0.938, showing that the overall structural fit of the model improved after revision. The Root Mean Square Error of Approximation (RMSEA) decreased from 0.046 to 0.036, and the Root Mean Square Residual (RMR) decreased from 0.106 to 0.049, indicating a reduction in model error and further proving the improved fit of the model. At the same time, the Comparative Fit Index (CFI) increased from 0.968 to 0.981, the Normed Fit Index (NFI) increased from 0.923 to 0.936, and the Non-Normed Fit Index (NNFI) increased from 0.962 to 0.977. These improvements indicate that the model's goodness of fit has been enhanced across all key indicators, and the revised model structure is more reasonable. Furthermore, the 90% confidence interval for RMSEA narrowed from 0.036–0.057 to 0.023–0.048, further demonstrating the stability of the revised model's fit. In summary, market governance, social governance, government governance, and the project collaboration process all have significant positive impacts on the success of metro commercial development

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projects. The revised structural equation model for the success of metro commercial development projects is shown in Figure 2.

Table 3. A revised conceptual model of the factors influencing the Metro Commercial Development

Common Indicators	χ2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI	TLI
Judgment Criteria	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9	>0.9
Value	1.389	0.938	0.036	0.049	0.981	0.936	0.977	0.977
Other indicators	AGFI	IFI	PGFI	PNFI	PCFI	SRMR	RMSEA 90% CI	
Judgment Criteria	>0.9	>0.9	>0.5	>0.5	>0.5	<0.1	-	
Value	0.917	0.981	0.701	0.778	0.815	0.038	0.023 ~ 0.048	

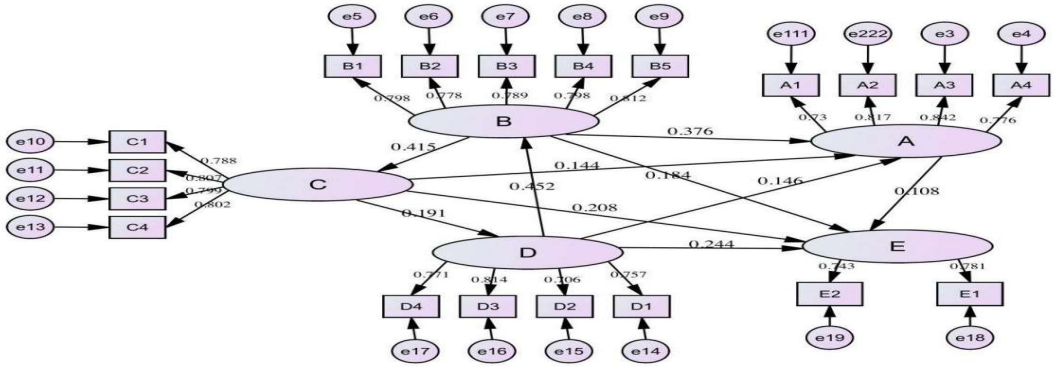

Figure 2. Fitting table of basic parameters of the factors influencing the Metro Commercial Development

3.5. Hypothesis Testing Results

From Table 4, it can be seen that the standardized regression coefficient of government governance on market governance is 0.415, with a z-value of 5.752 and a p-value of 0, indicating a significant positive correlation between government governance and market governance. Therefore, H1 is supported.

The standardized regression coefficient of social governance on government governance is 0.452, with a z-value of 6.265 and a p-value of 0, indicating that social governance has a significant positive impact on government governance. Therefore, H2 is supported.

The standardized regression coefficient of market governance on social governance is 0.191, with a z-value of 2.343 and a p-value of 0.019, showing that market governance has a significant positive impact on social governance. Therefore, H3 is supported.

The standardized regression coefficient of government governance on the internal collaboration process is 0.376, with a z-value of 4.743 and a p-value of 0, indicating that government governance has a significant positive impact on the internal collaboration process. Therefore, H4 is supported.

The standardized regression coefficient of market governance on the internal collaboration process is 0.144, with a z-value of 2.082 and a p-value of 0.037, indicating that market governance has a significant positive impact on the project collaboration process. Therefore, H5 is supported.

The standardized regression coefficient of social governance on the internal collaboration process is 0.146, with a z-value of 2.027 and a p-value of 0.043, indicating that social

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governance has a significant positive impact on the internal collaboration process. Therefore, H6 is supported.

The standardized regression coefficient of government governance on the success of metro commercial development projects is 0.184, with a z-value of 2.042 and a p-value of 0.041, indicating that government governance has a significant positive impact on project success. Therefore, H7 is supported.

The standardized regression coefficient of market governance on project success is 0.208, with a z-value of 2.662 and a p-value of 0.008, indicating that market governance has a significant positive impact on project success. Therefore, H8 is supported.

The standardized regression coefficient of social governance on project success is 0.244, with a z-value of 2.983 and a p-value of 0.003, indicating that social governance has a significant positive impact on project success. Therefore, H9 is supported.

The standardized regression coefficient of the internal collaboration process on project success is 0.108, with a p-value of 0.175, indicating that its positive impact is not significant. Therefore, H10 is not supported.

In summary, hypotheses H1 to H9 are supported, while H10 is not supported. Government governance, market governance, and social governance play important roles in promoting the success of metro commercial development projects, with social governance having the greatest impact. However, the direct impact of the internal collaboration process on project success is not significant.

Table 4. Hypothesis test results

Relationship	Estimate	z (CRValue)	P	Corresponding Hypothesis	Test Result
Internal Collaboration Process → Success of Metro Commercial Development Projects	0.108	1.355	0.175	H1	Not Supported
Government Governance → Internal Collaboration Process	0.376	4.743	0.000	H2	Supported
Government Governance → Market Governance	0.415	5.752	0.000	H3	Supported
Government Governance → Success of Metro Commercial Development Projects	0.184	2.042	0.041	H4	Supported
Market Governance → Internal Collaboration Process	0.144	2.082	0.037	H5	Supported
Market Governance → Social Governance	0.191	2.343	0.019	H6	Supported
Market Governance → Success of Metro Commercial Development Projects	0.208	2.662	0.008	H7	Supported
Social Governance → Internal Collaboration Process	0.146	2.027	0.043	H8	Supported
Social Governance → Government Governance	0.452	6.265	0.000	H9	Supported
Social Governance → Success of Metro Commercial Development Projects	0.244	2.983	0.003	H10	Supported

3.6. Analysis of Influencing Factors

This study calculated the predictive power of the observed variables for their respective latent variables based on the model's results and ranked them accordingly. The specific ranking results are presented in Table 5.

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Table 5. The relative importance of the influencing factors measure variables to their respective latent variables

Variable Relationship			Standardized Regression Coefficient	Predictive Power	Importance Ranking
Internal Collaboration Process	→	Risk Assessment	0.843	0.710649	1
Internal Collaboration Process	→	Responsibility Division	0.815	0.664225	2
Internal Collaboration Process	→	Operational Benefits	0.775	0.600625	3
Internal Collaboration Process	→	Operational Costs	0.731	0.534361	4
Government Governance	→	Oversight Review	0.814	0.662596	1

From Table 5, it can be seen that risk assessment, oversight review, operational management, and supervision and evaluation rank highest in importance, followed by responsibility division, policies and regulations, interaction partners, and social environment. The higher the ranking, the greater the impact of the factor on the success of metro commercial development projects.

Specifically, in the process of promoting the success of metro commercial development projects, stakeholders, including government departments, enterprises, and the public, pay more attention to risk assessment, oversight review, operational management, and supervision and evaluation. Among these, risk assessment can effectively identify and respond to potential risks, ensuring the smooth progress of the project; oversight review ensures that government governance is compliant and orderly; good operational management is key to market governance; and supervision and evaluation strongly promote social governance. Of course, other factors such as responsibility division, policies and regulations, interaction partners, and social environment should not be overlooked. They contribute to optimizing team collaboration, standardizing project operations, providing resource support, and creating a favorable atmosphere, collectively forming a comprehensive project impact system that ensures the smooth progress and successful implementation of the project.

4. Conclusion

(1) A structural equation model for the success of metro commercial development projects from a multi-center governance perspective was constructed. Using AMOS software for validity, reliability analysis, and path testing, the revised model confirmed that social governance, market governance, and government governance have significant positive impacts on project success, while the direct impact of the project collaboration process is not significant. This proves that the model is effective and has analytical value.

(2) Through data analysis, it was found that among the factors influencing project success, social governance has the greatest impact, with a standardized regression coefficient of 0.244; market governance follows, with a coefficient of 0.208; and government governance has the least impact, with a coefficient of 0.184. The observed variables under each latent variable also show differences in importance ranking. For example, in the internal collaboration process, risk assessment is the most important (standardized regression coefficient of 0.843).

Future research could expand the sample size to include more cities and types of metro commercial development projects to further validate the model's universality. At the same time, given the differences in policy environments, market demands, and social cultures across different cities, subsequent studies should focus on the role of these regional differences in the

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model and the factors influencing project success, thereby improving the theoretical model and providing more precise guidance for metro commercial development practices.

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