Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 9, No. 3, June, 2025

The Impact of Interactive Behaviour on Service Quality: The Role of Relationship Quality, External Environment

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Abstract

This study explores the impact of interactive behaviour, relationship quality, and the external environment on the quality of urban public services, as well as their mechanisms of action. Correlation analysis (CA) was used to assess the relationships between variables, while a structural equation modelling (SEM) analysed the complex links among interactive behaviour, relationship quality, public service quality, and the external environment. Additionally, principal component analysis (PCA) and K-Means clustering techniques were applied to reveal intrinsic relationships between variables. The findings indicate that interactive behaviour indirectly enhances public service quality by improving relationship quality, with the external environment playing a significant moderating role in this process. The model fit indices (CFI, RMSEA, chi-square statistics) confirmed the model's interpretability and consistency with the data. The innovation of this study lies in the integration of PCA and K-Means clustering into the SEM model, providing a more comprehensive framework for analysing variable relationships. This research offers a theoretical foundation and practical guidance for policymakers seeking to optimize public service management strategies, government departments aiming to strengthen cooperation, and scholars working to deepen related research.

Keywords:

Public Service Quality; Governance Models; Multi-Supplier Cooperation; Interactive Behaviors; Relationship Quality; External Environment; SEM.

Article History:

Received:	14	December	2024
Revised:	16	April	2025
Accepted:	20	April	2025
Published:	01	June	2025

1- Introduction

The 20th National Congress of the Chinese Communist Party in 2022 identified a key social contradiction: the widening gap between "uneven and inadequate development" and "the people's ever-growing needs for a high-quality life" [1]. This contradiction is most evident in the public service sector, which is essential for enhancing citizens' well-being and driving economic growth. Despite progress, China's social system remains imperfect, and its market framework is still evolving, leaving the country at the lower end of the global value chain [2]. Optimizing public services has thus become an urgent task for achieving higher levels of development, particularly through the integration of the real economy with the urban living experience.

In economically developed regions, especially along the southern coast, smart city construction is being vigorously promoted [3]. The provision of high-quality public services plays a decisive role in attracting talent, maintaining social harmony, and stimulating economic vitality. This study focuses on three cities in Guangdong Province—Guangzhou, Dongguan, and Zhongshan—which represent different stages of urban development. Specifically, Guangzhou

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DOI: http://dx.doi.org/10.28991/ESJ-2025-09-03-011

exemplifies a developed city, Dongguan a rapidly industrializing city, and Zhongshan a medium-sized city. This diversity allows the findings to serve as a reference for other regions in China at similar stages of development. For instance, Guangzhou's experience may be applicable to other first-tier cities, Dongguan's model may be relevant to rapidly industrializing cities, and Zhongshan's situation may provide insights for small and medium-sized cities. As one of China's most economically advanced provinces, Guangdong has developed public service policies that can serve as a reference for other regions, particularly in enhancing regional competitiveness through public services. However, China's public service system differs significantly from the market-driven governance models of Western countries, limiting the direct applicability of these research findings internationally.

The quality of public services directly impacts regional development, particularly in areas such as healthcare, education, urban infrastructure, housing, and public safety [4]. These services influence residents' satisfaction, work efficiency, and consumer behaviour. Conversely, inefficient service management can diminish residents' well-being and hinder economic growth (Shanghai Institute of Quality and Standardization, 2015).

Local governments are facing increasing financial pressure due to large-scale tax and fee reductions [5], prompting them to adopt innovative governance models to improve service delivery in sectors such as healthcare, education, and transportation. Effective public service delivery requires collaboration between government agencies, businesses, social organizations, and the public [6]. This collaborative model should emphasize equal consultation, resource sharing, and technical exchanges to ensure the efficient allocation of resources.

To address these challenges, there has been a growing trend toward adopting collaborative models that involve multiple service providers. Previous studies have examined the roles of government, businesses, social organizations, and the private sector in public service delivery. Ma & Dong (2010) [7] advocated for stronger government-society collaboration and greater autonomy for community organizations. However, implementing this cooperative model presents practical challenges. Zheng (2018) [8] highlighted the underutilization of public cultural facilities and suggested adopting a decentralized model, similar to that of the United States, to more effectively integrate market and social resources.

There is a significant gap in the existing research regarding concrete guidance on how different stakeholders can effectively collaborate to enhance the quality of public services [9]. Empirical studies are essential to examining stakeholders' roles in depth, establishing a cooperation framework, and assessing the extent of private sector participation amid financial constraints [10].

The government-led model lacks equal consultation: Existing research has primarily focused on the government-led public service delivery model, often neglecting consultation and co-governance with the market, social organizations, and the public [11]. An overly prescriptive cooperation model limits the enthusiasm and autonomy of multiple actors, negatively affecting service efficiency and quality.

Unclear roles and responsibilities of multiple stakeholders: The lack of transparency in systems and policies has blurred the roles of the government, enterprises, social organizations, and the public, leading to challenges in resource allocation and accountability [12, 13]. The role of social organizations remains undervalued, while market-based supply mechanisms struggle to function effectively.

Limited participation of social organizations and citizens: Although the involvement of social organizations and citizens is increasingly recognized, their participation remains limited [14]. Social organizations lack resource support and policy guarantees, while citizen engagement remains low, restricting the diversity and flexibility of public service provision.

Insufficient private sector involvement: With rising fiscal pressures on local governments, effectively integrating the private sector into public service provision has become a critical challenge [15, 16]. Financial constraints have affected service quality in sectors such as education, healthcare, and environmental management [5], necessitating further exploration of private sector participation mechanisms.

Unclear division of labour between government and market: The division of responsibilities between the government and the market remains ambiguous, particularly in infrastructure, education, and healthcare. Excessive government intervention leads to inefficiencies, while monopolistic enterprises lack incentives for innovation, exacerbating service supply imbalances [17, 18].

Weak cooperation mechanisms and policy design: Although multi-party collaboration is widely advocated in theory, practical implementation lacks clear mechanisms for benefit distribution, rights and responsibilities allocation, and resource sharing [19, 20].

Existing research lacks systematic empirical analysis of multi-party collaborative governance models, particularly in cities facing high fiscal pressures. This study aims to address these research gaps by exploring the dynamic mechanisms of multi-stakeholder collaboration, with a focus on stakeholder role definition, collaborative framework design, and private sector participation under fiscal constraints.

This study aims to achieve the following objectives:

1. To examine the interactive influence of urban public service providers on service quality.
2. To analyse the mediating role of relationship quality in the link between interactive behaviour and public service quality.
3. To investigate the moderating effect of the external environment on the relationship between relationship quality and service quality.

Based on these objectives, this study seeks to answer the following research questions:

1. Does the interactive behaviour of urban public service suppliers affect the quality of relationships among suppliers?
2. Does the interactive behaviour of suppliers influence public service quality?
3. Does the quality of relationships among suppliers affect service quality?
4. Does relationship quality mediate the impact of interactive behaviour on service quality?
5. Does the external environment moderate the relationship between relationship quality and service quality?

2- Theoretical Framework

2-1- Relational Governance Theory

Relationship governance originates from Macneil's [21] relational contract theory, which emphasizes the importance of trust in contractual relationships [22]. Richardson [23] linked it to production activities, while Anderson & Narus [24] identified trust as its core element. Heide & John [25] defined it as a mechanism based on shared goals, trust, and cooperation, aimed at protecting proprietary assets. Heide [26] further refined it as a means of regulating ongoing interactions between organizations. Zaheer & Venkatraman [27] described it as transactions involving significant relational assets. Zheng & Roehrich [28] advocated integrating relational and contractual governance to improve transaction outcomes.

Poppo & Zenger [29] emphasized norms such as trust and cooperation, while Peng [30] highlighted its role in adapting to environmental changes and fostering collaboration. Navarro-Garcia et al. [31] defined it as managing organizations through interpersonal relationships and social coordination. Dong & Zhuang [32] argued that relationship governance enhances engagement and creativity, with relationship quality serving as its external manifestation. Levitt [33] considered it an intangible asset that influences organizational performance [34]. Storbacka et al. [35] explored its dynamic relationship with business performance, emphasizing satisfaction, commitment, and communication.

Chen & Chen [36] noted that relationship quality affects emotional attachment and perceived obligation. Liu et al. [37] examined its influence on ethical decision-making, particularly in mutually beneficial scenarios. Coletta et al. [38] conceptualized it as a multidimensional construct comprising trust, commitment, and satisfaction.

2-2- Contingency Theory

Simpson & Fiedler [39] proposed contingency theory, asserting that organizational approaches should depend on task characteristics and environmental factors. Lawrence & Lorsch [40] and Burns & Stalker [41] emphasized that organizational structure should align with strategy, size, technology, and environment. Luthans et al. [42] argued that organizational success depends on the harmony between internal systems and the external environment. Coombs [43] highlighted its role in managing stakeholder relationships and advocated for adjusting strategies based on the external environment.

2-3- New Public Service Theory

Denhardt & Denhardt [44] proposed the theory of New Public Service, advocating that public institutions should "serve" rather than "guide" citizens, emphasizing citizen participation in governance [45]. The theory critiques

traditional hierarchical structures and promotes a cooperative framework involving government, the private sector, and citizens [46]. Chen et al. [47] highlight its emphasis on balancing public service value and effectiveness, prioritizing cooperation over control.

2-4- Relationship Between Theory and Hypotheses

Relationship governance, originating from Macneil [22, 48], emphasizes the interplay between transactions and social relationships. Research has highlighted its ability to enhance organizational efficiency [49] and improve project performance [50]. This study hypothesizes that:

1. Interactive behaviour positively impacts public service quality.
2. Relationship quality mediates the relationship between interactive behaviour and public service quality.
3. The external environment moderates the relationship between relationship quality and public service quality.

Contingency theory posits that strategic decisions depend on contextual variables [51] and that organizations must adapt their management approaches to their tasks and environment. These theoretical frameworks highlight the complex dynamics among relationship governance, public service quality, and the external environment.

2-5- Conceptual Framework of This Study

This study builds on existing research and theoretical frameworks, suggesting that interactions among public service providers play a crucial role in shaping the quality and efficiency of urban public services through the relationships established between these entities. Additionally, it explores the external environment's moderating influence on service provider relationships and its subsequent impact on urban public service quality. One key aspect of this investigation is assessing how the external environment moderates urban public service quality.

Guided by the three underlying theories—relationship governance theory, new public service theory, and contingency theory—this study analyses three key variables: interactive behaviour, external environment, and relationship quality.

Interactive behaviour: Heide & John [25] identified trust, commitment, cooperation, and joint problem-solving as essential components of interaction. Fathi et al. [52] categorized the interaction process in public-private partnerships into four stages: strategic planning, collaborative development, collaborative implementation, and collaborative evaluation, all emphasizing trust and communication mechanisms. Ansell & Gash [53] proposed the SFIC model, highlighting system design and the collaborative process, including face-to-face dialogue, trust-building, investment, consensus, and interim results. Tang [54] identified three dimensions of interactive behaviour: communication process, mutual exchange, and collaborative experience. Li et al. [55] emphasized the role of trust, communication, and shared goals in multi-stakeholder collaboration, while Yang et al. [56] further explored trust and commitment-building mechanisms. This study adopts Tang's [54] measurement indicators: communication process, mutual exchange, and collaborative experience.

External environment: Fathi et al. [52] defined the external environment of collaborative governance as encompassing legal system coordination, civic role transformation, leadership relationship establishment, public participation mechanisms, and private sector participation channels. Thusi et al. [57] expanded this scope to include economic and social development levels, policy and legal frameworks, historical experiences, and network conditions. Bingham [58] and Mayhew [59] emphasized the impact of policies and laws on multi-stakeholder collaboration. Wei et al. [60] classified the institutional environment into three subcategories: regulatory pressure, normative pressure, and cognitive pressure. Tang [54] defined the external environment as comprising upper-level support, regulatory policies, and public participation. This study adopts Tang's [54] measurement method, adjusting it as needed for research purposes. Tang's [54] scale, which builds upon the work of Mulhern FJ and others, is more comprehensive and focuses on the measurability of relationship dimensions, making it more suitable for the present study. Fathi et al. [52] and Thusi et al. [57] emphasized the external environment's influence on collaborative governance. Bingham [58] and Mayhew [59] highlighted policies and laws as fundamental to multi-stakeholder governance.

Based on these variables, this study develops a conceptual framework (as shown in Figure 1) to test the proposed hypotheses. The framework integrates the relationships among interactive behaviour, external environment, and relationship quality, providing a solid theoretical foundation for the study.

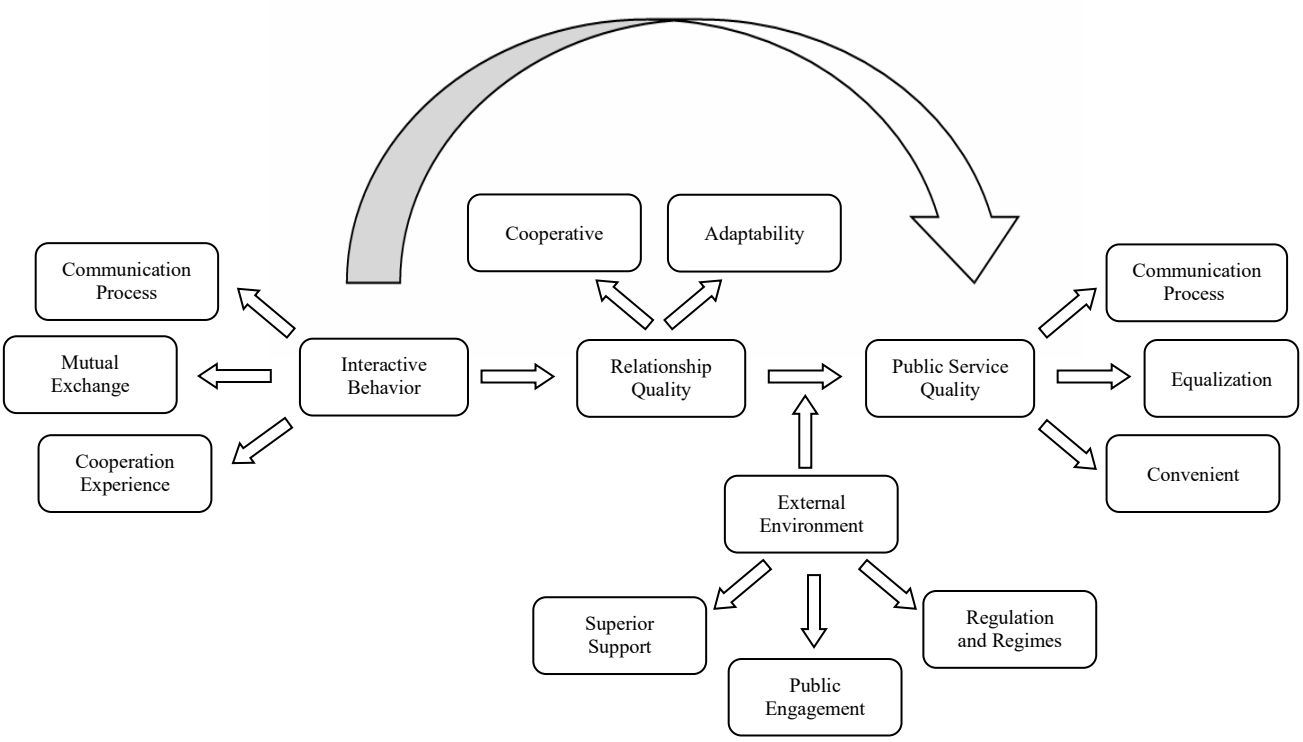

Figure 1. Conceptual Framework Diagram

3- Research Methodology

3-1-Sampling Methods

Yamane [61] emphasized the importance of achieving a 95% confidence level, minimizing variance, and maintaining a 5% margin of error (E). Later, Yamane [62] provided a formula where N represents the population and e denotes the margin of error. Based on this formula, the minimum sample size required for this study was determined to be 400.

To conduct this study, we developed a comprehensive database of public service organizations in cities with diverse structural characteristics. The database was customized to reflect the unique contexts of three carefully selected cities. During the preparation process, we collaborated closely with local statistics bureaus and government agencies and consulted the official statistical yearbooks of each city. Using random sampling techniques, 400 respondents were selected from a wide range of service providers listed in the sampling frames of these cities. Additionally, 50 respondents were randomly chosen from the general population of the designated cities.

Before participating in the survey, citizens were informed about the academic purpose of the study and the confidentiality policy to ensure their understanding and consent. Table 1, Table 2, Table 3 that follow present the distribution of diversified public service entities in the cities based on data from the 2022 statistical year. And Table 4 provides the number of samples selected from each of the three cities. Table 5 provides the number of samples selected from ordinary urban residents in each of the three cities. Table 6 provides the number of samples selected from public service organizations in each of the three cities.

Table 1. Indicators of Guangzhou in 2022

Public service	Number
Basic Statistics of Scientific Research and Development Institutions	189
Basic Statistics on Education	1778
Resources and Services on Medical Institutions	6159
Social organizations that provide social insurance	8004
Basic cultural service unit	104

Source: The data is based on the Guangzhou Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Guangzhou. Guangzhou Statistical Yearbook 2023. © 2023 China Statistics Press Co., Ltd.

Table 2. Indicators of Dongguan in 2022

Public service	Number
Basic Statistics of Scientific Research and Development Institutions	39
Basic Statistics on Education	1914
Resources and Services on Medical Institutions	3696
Social organizations that provide social insurance	107
Basic cultural service unit	715

Source: The data is based on the Dongguan Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Dongguan. Dongguan Statistical Yearbook 2023. © 2023 China Statistics Press Co., Ltd.

Table 3. Indicators of Zhongshan in 2022

Public service	Number
Basic Statistics of Scientific Research and Development Institutions	0
Basic Statistics on Education	911
Resources and Services on Medical Institutions	1280
Social organizations that provide social insurance	1098
Basic cultural service unit	13

Source: The data is based on the Zhongshan Municipal Bureau of Statistics and Survey Office of the National Bureau of Statistics in Zhongshan. Zhongshan Statistical Yearbook 2023. © 2023 China Statistics Press Co., Ltd.

Table 4. Sample Size Calculations for the Three Cities

Shore	Demographic (10,000)	Stratified random sampling	Sample size
Guangzhou subprovincial city and capital of Guangdong	1873.41	1873.41/3360.22*400	223
Dongguan	1043.7	1043.7/3360.22*400	124
Zhongshan Station	443.11	443.11/3360.22*400	53
Add up the total	3360.22		400

Note:. The above data were obtained from the government websites of the respective cities.

Table 5. Sample Size of Ordinary Citizens in Three Cities

Shore	Demographic (10,000)	Stratified random sampling	Sample size
Guangzhou subprovincial city and capital of Guangdong	1873.41	1873.41/3360.22*400	28
Dongguan	1043.7	1043.7/3360.22*400	15
Zhongshan Station	443.11	443.11/3360.22*400	7
Add up the total	3360.22		50

Note: The above data were obtained from the government websites of the respective cities.

Table 6. Sample Size of Public Service Organizations in Each City

City	Sample Size	Public service types	Proportionally obtained quantities (Base on Sample Size)
Guangzhou	223	Basic statistics of scientific research and development institutions	3
		Basic Statistics on Education	24
		Resources and Services on medical institutions	85
		Social organizations that provide social insurance	110
		Basic cultural service unit	1
Dongguan	124	Basic statistics of scientific research and development institutions	1
		Basic Statistics on Education	37
		Resources and Services on medical institutions	71
		Social organizations that provide social insurance	2
		Basic cultural service unit	14
Zhongshan Station	53	Basic statistics of scientific research and development institutions	0
		Basic Statistics on Education	14
		Resources and Services on medical institutions	20
		Social organizations that provide social insurance	18
		Basic cultural service unit	1

Note: The above data were obtained from the government websites of the respective cities.

3-2- Data Collection

After finalizing the questionnaire, three main methods were used for data collection and testing: 1) In-person distribution and interviews – Questionnaires were distributed in person, allowing for simultaneous interviews. This approach facilitated direct contact with respondents, ensuring authentic and reliable background information. 2) Electronic questionnaire via Sojump – An electronic version of the questionnaire was created using the Sojump platform, developed in 2006 in Changsha. Sojump integrates data collection, analysis, and online surveys. As of January 2023, it had distributed 235 million questionnaires and received 18.726 billion responses [63]. 3) Dissemination through digital and social media – Questionnaires were shared via digital and social media platforms such as WeChat and QQ. Additionally, WeChat media tools were leveraged to enhance respondent participation.

3-3- Data Analysis Methods

3-3-1- Data Preparation

The data preparation phase involves identifying and excluding inappropriate questionnaires. The exclusion criteria include: 1) more than two-thirds of the items left unanswered; 2) contradictions in reverse-coded questions; 3) the same response selected for all items; 4) obvious response patterns; and 5) multiple answers selected for single-choice questions.

Following this, coding and data entry are conducted. Multiple-choice responses are converted into numerical codes (e.g., "yes" as 1 and "no" as 2), while quantitative responses are directly transcribed as numerical values. After data entry, data cleaning is performed to correct input errors, handle missing values and outliers, and ensure the dataset is ready for subsequent analysis [64].

3-3-2- Descriptive Statistics

The pilot study assessed the feasibility of the research design and data collection tools by randomly sampling 80 participants from government departments, businesses, and social organizations. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted to validate the composition of the higher-order constructs, confirm that all indicators were significantly correlated with their respective constructs, and ensure the robustness of the theoretical framework.

3-3-3- Correlation Analysis

Descriptive statistics summarize the characteristics of the data using charts, graphs, and tables, presenting key attributes of the sample (e.g., age, gender, education level, and occupation). This process provides a foundational overview for subsequent analysis [65].

3-3-4- Structural Equation Modelling (SEM) Analysis

Correlation analysis examines the linear relationship between variables and assesses the strength of the association between the independent variable (interactive behaviour), the dependent variable (quality of urban public services), and the mediating variable (relationship quality). The correlation coefficient ranges from -1 to 1, where positive values indicate a direct association and negative values indicate an inverse association. The Pearson method is used for normally distributed data, while the Spearman method is applied to non-normally distributed data [66-68].

3-3-5- Mediation Effect Analysis

SEM constructs complex models using path analysis to examine interactions between variables while accounting for latent variables (e.g., relationship quality and external environment) and their measurement errors. SEM simultaneously manages multiple causal paths and provides model fit indices (such as CFI, RMSEA, and χ^2) to assess model interpretability [68, 69].

3-3-6- Intermediary Effect Analysis

This study examines whether interactive behaviour indirectly influences the quality of urban public services by enhancing relationship quality. SEM was used to assess the direct and indirect effects of interactive behaviour on relationship quality and the impact of relationship quality on service quality. This analysis of the mediating path highlights the crucial role of relationship quality in multi-agent cooperation.

3-3-7- Analysis of the Moderating Effect

SEM was used to examine how the external environment moderates the relationship between relationship quality and the quality of urban public services. The moderating effect was assessed by incorporating an interaction term ($M \times W$) to ensure the accuracy and robustness of the results [70].

4- Results

Data analysis (formal large-scale analysis of the overall scale n=400)

4-1- Descriptive Statistical Analyses

Table 7 presents the results of the descriptive statistical analysis of the subjects surveyed in this study.

Table 7. Participant Demographic Details (n=400)

		Frequency	Percentage (%)
Gender	Male	232	58.0%
	Female	168	42.0%
Age	<25year	33	8.3%
	26year-35year	108	27.0%
	36year-45year	114	28.5%
	46year-55year	121	30.3%
	>55year	24	6.0%
Educational background	Vocational education	28	7.0%
	Undergraduate	207	51.7%
	Master's degree or above	145	36.3%
	Other	20	5.0%
Position	Government agent	149	37.3%
	Employees of social organizations	166	41.5%
	Enterprise employees	85	21.3%

4-2- Descriptive Statistics and Correlation Analysis

Correlation analysis is a statistical method used to study the relationship between variables and to assess how a change in one variable affects or corresponds to a change in another variable. This study correlated the interaction of behavioural aspects, relationship quality, the external environment and the effectiveness of public services. Given the non-normal distribution of the data (as evidenced by the normality test), we used the Spearman correlation coefficient for the analysis, which was carried out using SPSS version 22.0. The table 8 summarises the correlation coefficients obtained.

The results of the analysis show that there is a statistically significant positive correlation between the above variables, i.e. interaction, relationship quality, external environment and public service effectiveness. Specifically, the calculated correlation coefficients were 0.807, 0.847 and 0.898, respectively, all of which were statistically significant at the 0.01 level. These results indicate that there is a strong positive correlation between the variables investigated. This initial analysis provides important support for subsequent hypothesis testing within the wider scope of the study.

Table 8. Spearman's Correlation between Variables (n=400)

	Interactive behaviour	Relationship quality	External environment	Public service effectiveness
Interactive behaviour	1			
Relationship quality	0.871**	1		
External environment	0.846**	0.879**	1	
Public service effectiveness	0.807**	0.847**	0.898**	1

** indicates that all correlation coefficients are highly significant at the 0.01 level.

4-3- Evaluation of Measurement Models

4-3-1- Reliability Analysis

Utilizing SPSS version 22.0 software for data analysis, the resulting output of reliability analysis for each scale was acquired. The mean values of the respective scales surpassed 0.70, indicating a high level of reliability and satisfying the prerequisites of the study (Tables 9 and 10).

Table 9. Reliability Analyses of Formal Scales

	Cronbach's alpha	Split-half	Combination reliability CR value	Number of items
Communication process	0.884	0.895	0.886	4
Reciprocal exchange	0.837	0.814	0.837	4
Collaboration experience	0.795	0.804	0.799	3
Cooperativeness	0.867	0.843	0.867	3
Adaptability	0.785	0.792	0.787	3
Superior support	0.919	0.897	0.919	6
Rules and regulations	0.846	0.851	0.847	3
Public participation	0.861	0.844	0.862	3
Universal accessibility	0.914	0.906	0.915	4
Equalization	0.752	0.739	0.772	3
Convenience	0.714	0.708	0.733	3

4-3-2- Validity Analysis

Validity reflects whether the measurement tool accurately measures the desired latent variable. Two main criteria are generally used to assess the validity of a measurement tool (Tables 10 and 11):

Convergent Validity*:* Refers to whether multiple observed variables accurately measure the same latent variable. It is usually assessed by average variance extraction (AVE), with an AVE value above 0.50 as the benchmark.

Discriminant Validity (DV): Refers to whether there are significant differences between different latent variables. It can be assessed by the following methods:

The Fornell-Larcker criterion states that the square root of the AVE of a latent variable should exceed its correlation with other latent variables in order to establish discriminant validity.

HTMT (heterotrait-monotrait ratio): A HTMT value below 0.85 is required to indicate robust discriminant validity.

Table 10. Spearman Correlation and AVE Indicators

	Communication process	Reciprocal exchange	Collaboration experience	Cooperativeness	Adaptability
Communication process	0.813				
Reciprocal exchange	0.812**	0.85			
Collaboration experience	0.751**	0.828**	0.855		
Cooperativeness	0.776**	0.804**	0.834**	0.828	
Adaptability	0.742**	0.717**	0.749**	0.793**	0.843
Superior support	0.716**	0.704**	0.708**	0.768**	0.786**
Rules and regulations	0.774**	0.703**	0.691**	0.757**	0.744**
Public participation	0.746**	0.661**	0.656**	0.730**	0.757**
Universal accessibility	0.759**	0.759**	0.737**	0.783**	0.755**
Equalization	0.717**	0.701**	0.699**	0.719**	0.786**
Convenience	0.739**	0.671**	0.661**	0.716**	0.802**

** indicates that all correlation coefficients are highly significant at the 0.01 level.

Table 11. Spearman Correlation and AVE Indicators (Continued)

	Superior support	Rules and regulations	Public participation	Universal accessibility	Equalization	Convenience
Communication process						
Reciprocal exchange						
Collaboration experience						
Cooperativeness						
Adaptability						
Superior support	0.859					
Rules and regulations	0.829**	0.805				
Public participation	0.834**	0.804**	0.822			
Universal accessibility	0.790**	0.780**	0.749**	0.854		
Equalization	0.755**	0.758**	0.758**	0.777**	0.739	
Convenience	0.759**	0.793**	0.769**	0.705**	0.738**	0.693

** indicates that all correlation coefficients are highly significant at the 0.01 level.

The square root of the AVE for the latent variable surpassed its correlation coefficient with other latent variables, all of which exceeded the threshold of 0.5. This observation suggests a strong discriminant validity among the constructs (Tables 12 and 13).

Table 12. HTMT Correlation Ratio

	Communication process	Reciprocal exchange	Collaboration experience	Cooperativeness	Adaptability
Communication process	-				
Reciprocal exchange	0.755	-			
Collaboration experience	0.705	0.709	-		
Cooperativeness	0.78	0.53	0.478	-	
Adaptability	0.777	0.583	0.552	0.535	-
Superior support	0.704	0.513	0.436	0.57	0.493
Rules and regulations	0.782	0.554	0.436	0.59	0.486
Public participation	0.732	0.784	0.797	0.438	0.401
Universal accessibility	0.741	0.474	0.869	0.885	0.578
Equalization	0.77	0.784	0.411	0.403	0.411
Convenience	0.724	0.786	0.89	0.921	0.466

Table 13. HTMT Correlation Ratio (Continued)

	Superior support	Rules and regulations	Public participation	Universal accessibility	Equalization	Convenience
Communication process						
Reciprocal exchange						
Collaboration experience						
Cooperativeness						
Adaptability						
Superior support	-					
Rules and regulations	0.445	-				
Public participation	0.417	0.414	-			
Universal accessibility	0.577	0.499	0.441	-		
Equalization	0.513	0.555	0.425	0.42	-	
Convenience	0.934	0.569	0.574	0.596	0.592	-

All HTMT values are below the critical value of 0.85, thus indicating discriminant validity in the data. The validity of the assessment measurement instrument can be determined by the standard values in Tables 9 and 10.

4-3-3- Standardized Factor Loadings

The standardized factor load is an indicator of the extent to which the observed variable can explain the latent variable. In general, the factor load should exceed 0.50, with a value closer to 1 indicating a closer relationship. Conversely, if the factor load is low, it indicates that the observed variable is not sufficient to capture the latent variable (Table 14).

Table 14. KMO and Bartlett Inspection

KMO sampling suitability quantity		0.897
Bartlett's sphericity test	Last read card square	1139.910
	Degree of freedom	153
	Significance	0.000

The current study utilized SPSS 22.0 software to conduct the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity on the aggregated data set. The ensuing outcomes are presented in the Tables 15 and 16. The KMO value yielded a coefficient of 0.897, coupled with a statistically significant Bartlett's sphericity test result of 0.000. These findings demonstrate the fulfilment of validity requirements and signify the appropriateness of the sample data for subsequent factor analysis.

Table 15. Factor Loading Table

	1	2	3	4	5	6	7	8	9	10	11
A1	0.84	0.03	0.05	-0.09	-0.10	-0.05	-0.06	0.06	-0.06	0.13	-0.09
A2	0.83	0.23	0.22	0.04	0.13	0.15	-0.30	-0.04	-0.06	-0.08	-0.03
A3	0.82	0.04	-0.07	0.00	-0.03	-0.01	-0.03	0.32	0.05	0.06	-0.06
A4	0.80	0.09	0.39	0.09	0.23	-0.10	-0.35	-0.08	0.20	-0.04	0.10
A5	0.02	0.79	0.40	-0.14	0.05	0.27	0.04	0.13	-0.14	0.18	0.20
A6	-0.32	0.78	0.01	0.13	0.01	0.21	0.27	-0.14	-0.19	-0.28	0.32
A7	-0.33	0.75	-0.21	0.00	-0.20	0.08	0.36	-0.24	0.30	-0.05	0.00
A8	-0.05	0.66	0.13	0.01	0.12	0.13	-0.02	-0.04	0.23	-0.03	0.10
A9	-0.05	0.20	0.61	0.06	0.08	0.27	0.10	0.10	-0.03	0.29	-0.09
A10	-0.13	0.03	0.56	0.07	-0.13	-0.26	-0.08	0.07	-0.02	0.15	0.18
A11	0.15	0.14	0.50	0.03	0.07	0.11	0.10	0.49	0.01	-0.23	-0.22
A12	0.16	0.21	0.80	0.85	0.26	-0.01	0.10	0.11	0.12	0.10	-0.02
A13	0.05	0.20	0.40	0.84	-0.02	-0.03	0.07	0.28	0.08	-0.02	-0.08
A14	-0.06	0.17	0.08	0.79	0.43	-0.17	-0.07	0.63	-0.24	0.04	0.16
A15	0.09	-0.07	0.35	0.03	0.75	-0.10	0.11	-0.14	-0.21	0.03	-0.12
A16	0.08	0.17	0.08	0.13	0.73	-0.31	0.10	0.39	-0.08	0.02	-0.07
A17	0.21	-0.05	-0.13	0.79	0.72	0.16	-0.08	-0.05	0.12	-0.11	-0.04
A18	-0.39	0.00	-0.05	0.23	0.08	0.83	0.28	-0.12	-0.11	-0.07	0.27
A19	-0.01	-0.05	0.14	0.02	0.06	0.80	0.02	0.11	0.03	0.14	0.03
A20	0.18	-0.16	0.17	0.05	-0.17	0.77	0.26	0.07	0.09	0.07	0.05
A21	0.05	0.25	0.07	0.05	-0.01	0.73	-0.27	0.08	-0.13	-0.11	-0.24
A22	0.07	0.09	0.12	0.29	0.06	0.72	-0.05	0.04	0.24	0.06	0.11
A23	0.07	-0.06	0.24	0.25	0.12	0.70	0.29	0.04	0.02	-0.14	-0.17
A24	0.05	-0.01	0.04	0.05	0.08	0.02	0.87	0.05	0.14	-0.04	-0.03
A25	0.07	0.06	-0.07	0.17	0.10	0.08	0.84	-0.22	-0.18	0.03	-0.01
A26	0.34	-0.09	0.01	0.04	0.01	-0.02	0.82	0.14	0.11	-0.05	-0.18
A27	0.03	0.10	-0.11	0.10	-0.12	-0.13	0.00	0.79	0.13	0.12	0.20
A28	0.05	-0.24	0.09	0.26	0.15	-0.01	-0.09	0.72	-0.01	-0.14	-0.07
A29	0.00	0.09	0.09	0.00	-0.02	-0.02	0.02	0.62	-0.15	-0.20	-0.07
A30	0.27	0.10	0.09	-0.17	-0.14	0.15	-0.30	0.00	0.77	0.00	0.29
A31	0.03	0.21	0.21	0.01	0.03	0.02	-0.05	-0.02	0.73	0.22	-0.02
A32	0.09	0.09	0.09	0.12	0.16	0.17	-0.12	0.00	0.69	0.28	0.11
A33	0.06	-0.25	0.02	0.11	0.03	0.14	0.03	-0.05	0.55	0.04	0.24
A34	-0.17	0.22	0.26	0.07	0.09	0.07	0.05	-0.04	0.29	0.55	0.02
A35	-0.01	0.19	-0.27	0.08	-0.13	-0.11	-0.24	0.02	0.24	0.54	0.14
A36	0.05	-0.01	0.19	-0.27	0.23	0.43	-0.17	-0.07	0.63	0.56	0.12
A37	0.29	0.06	-0.05	-0.05	0.09	0.12	-0.10	0.11	-0.14	0.02	0.75
A38	0.25	0.12	-0.04	0.09	0.02	0.11	-0.27	0.08	-0.27	0.08	0.79
A39	0.05	0.08	0.02	0.24	0.26	0.07	0.19	-0.27	0.19	-0.27	0.64

Note: 1-11 respectively represent: communication process, mutual benefit and exchange, cooperative experience, cooperativeness, adaptability, support from superiors, rules and regulations, public participation, inclusiveness, equalization, and convenience.

Table 16. Factor Loadings Table for Latent Variables

	Dimension	Title	Standard load factor	Standard error	z (CR value)	p
Interactive behaviour	Communication process	Y1	0.798	-	-	-
		Y2	0.84	0.056	20.594	0.000
		Y3	0.808	0.055	19.089	0.000
		Y4	0.783	0.053	18.513	0.000
	Reciprocal exchange	Y5	0.759	-	-	-
		Y6	0.673	0.067	14.4	0.000
		Y7	0.812	0.07	17.332	0.000
		Y8	0.8	0.072	16.89	0.000
	Collaboration experience	Y9	0.725	-	-	-
		Y10	0.781	0.07	15.678	0.000
		Y11	0.775	0.075	16.023	0.000
Relationship quality	Cooperativeness	Y12	0.832	-	-	-
		Y13	0.809	0.05	21.052	0.000
		Y14	0.83	0.046	21.869	0.000
	Adaptability	Y15	0.779	-	-	-
		Y16	0.697	0.056	15.782	0.000
		Y17	0.777	0.053	17.422	0.000
External environment	Superior support	Y32	0.801	-	-	-
		Y33	0.793	0.051	18.934	0.000
		Y34	0.833	0.049	19.859	0.000
		Y35	0.83	0.052	19.399	0.000
		Y36	0.847	0.051	20.457	0.000
		Y37	0.796	0.054	19.008	0.000
	Rules and regulations	Y26	0.797	-	-	-
		Y27	0.813	0.058	19.243	0.000
		Y28	0.815	0.06	19.603	0.000
	Public participation	Y29	0.82	-	-	-
		Y30	0.825	0.049	20.528	0.000
		Y31	0.796	0.051	20.137	0.000
Public service effectiveness	Universal accessibility	Y18	0.848	-	-	-
		Y19	0.876	0.04	24.655	0.000
		Y20	0.827	0.042	21.502	0.000
		Y21	0.868	0.041	24.29	0.000
	Equalization	Y22	0.797	-	-	-
		Y23	0.872	0.047	20.281	0.000
		Y38	0.521	0.048	11.298	0.000
	Convenience	Y24	0.724	-	-	-
		Y25	0.752	0.072	16.494	0.000
		Y39	0.584	0.067	12.588	0.000

EFA shows that 11 factors can be extracted with a default eigenvalue >1, and that the 15 factors correspond to communication processes, reciprocity, cooperative experience, cooperativeness, adaptability, support from superiors, rules and regulations, public participation, inclusiveness, equalization, and facilitation. This is consistent with the expected dimension division (Table 17).

Table 17. Moderate Allocation Index Inspection Table

Fitting indicators	X2	df	C2/df	RMSEA	SRMR	CFI	TLI
	1081.465	647	1.672	0.046	0.036	0.936	0.927

In order to substantiate the theoretical soundness and practical applicability of the conceptual model, it is essential to ascertain the statistical significance of the Critical Ratio associated with the path coefficients. The statistical significance of the path coefficients is established at the significance level of p=0.05 when the Critical Ratio values of the paths exceed the standard reference value of 1.96.

For the purpose of validation factor analysis in this study, Mplus 7.0 software was utilised. Results revealed that the model fit indices met the criteria: RMSEA=0.046<0.08; SRMR=0.036<0.08; CFI=0.936>0.800; TLI=0.927>0.800. Further, all path coefficients were deemed statistically significant at the 0.001 level. As a result, it can be inferred that the model possesses a good fit and is suitable for measuring the variables under investigation in this study.

4-4- Assessment of Structural Models

4-4-1- Model Fit Assessment

The presented data Table 18 unveils pertinent statistical indicators of the structural equation model processed through the Mplus 7.0 software. The RMSEA is calculated at 0.06, falling below the widely acknowledged threshold of 0.08. Similarly, the SRMR stands at 0.027, also falling below the conventional cut-off of 0.08. Moreover, the CFI demonstrates a notable value of 0.956, surpassing the recommended threshold of 0.90. Additionally, the TLI registers at a commendable 0.952, exceeding the recognized standard of 0.95. The model is therefore well fitted. Table 19 shows the path coefficients between variables.

Table 18. Structural Model Fitting Index

Fitting indicators	C2/df	RMSEA	CFI	TLI	SRMA
Judgment criteria	<3	<0.10	>0.9	>0.9	<0.1
Judgment value	2.59	0.06	0.956	0.952	0.027

4-4-2- Path Coefficients

Table 19. Summary of Path Coefficients between Variables

			Standard coefficient	Standard error	t	Significance
	1	(Constant)		0.566	4.243***	0.000
H1	Relationship quality	Communication process	0.315	0.055	7.762***	0.000
H1a		Reciprocal exchange	0.172	0.074	3.553***	0.000
H1b		Collaboration experience	0.455	0.082	10.842***	0.000
H1c		Interactive behaviour	0.489	0.013	37.512***	0.000
H2	Public service effectiveness	Cooperativeness	0.451	0.14	11.259***	0.000
H2a		Adaptability	0.448	0.163	11.186***	0.000
H2b		Relationship quality	0.692	0.05	33.79***	0.000
H3	Public service effectiveness	Communication process	0.449	0.134	9.023***	0.000
H3a		Reciprocal exchange	0.151	0.18	2.552***	0.011
H3b		Collaboration experience	0.268	0.2	5.211***	0.000
H3c		Interactive behaviour	0.904	0.031	28.887***	0.000
H4	Public service effectiveness	Universal accessibility	0.368	0.091	10.792***	0.000
H4a		Equalization	0.261	0.131	7.492***	0.000
H4b		Convenience	0.365	0.133	11.506***	0.000
H4c		External environment	0.898	0.026	43.22***	0.000

Note: *p < 0.05; **p < 0.01; ***p < 0.00.

4-5- Mediation Effect Analysis

4-5-1- Direct Effect Test of Independent Variables on Dependent Variables

Firstly, the present study employed regression analysis using the software SPSS 22.0 to evaluate the direct impact of interaction behaviour, considered as the independent variable, on the quality of urban public services, defined as the dependent variable. The results indicate a notable connection between interaction behaviour and the effectiveness of public services in urban settings. Specifically, the standard regression coefficient associated with interaction behaviour is estimated at 0.904, presenting statistical significance at the 0.05 level. This finding underscores the substantial positive influence of interaction behaviour on enhancing the quality of urban public services (Table 20). Further analysis confirms the significant and direct influence of interaction behaviour on public service efficacy, expressed by the derived model equation: y (public service effect) = 7.129 + 0.904* interaction behaviour + ϵ.

Table 20. Direct Effect Test of Independent Variables on Dependent Variables

Model	Non standardized coefficient		Standard coefficient	t	p
	B	Standard error	Beta		
(Constant)	7.129	1.360		5.241	.000
Interactive behaviour	0.904	0.031	0.807	28.887***	.000
R^2	0.651				
Adjust R^2	0.65				
F-value	34.48***				

Note: *p < 0.05; **p < 0.01; ***p < 0.00.

4-5-2- Tests of the Effect of The Independent Variable on The Mediator Variable

Subsequently, an examination was conducted to ascertain the impact of interaction behaviour on relationship quality, serving as a mediator variable, in order to establish the significant influence exerted by the independent variable. These findings elucidate a scenario where interaction behaviour functions as the independent variable and relationship quality as the dependent variable. The regression coefficient attributed to interaction behaviour demonstrates a statistically significant value of 0.489, indicating a notable positive effect on relationship quality. The analysis further pertains to the discernment that interaction behaviour markedly enhances the quality of public relations, as denoted by the model: y (Quality of Relationship) = 2.541+ 0.489* Interaction Behaviour + ϵ (Table 21).

Table 21. Tests of the Effect of the Independent Variable on the Mediator Variable

Model	Non standardized coefficient		Standard coefficient	t	Significance
	B	Standard error	Beta		
(Constant)	2.541	0.567		4.485	0.000
Interactive behaviour	0.489	0.013	0.871	37.512***	0.000
R^2	0.759				
Adjust R^2	0.758				
F-value	27.16***				

Note: *p < 0.05; **p < 0.01; ***p < 0.00.

4-5-3- Tests of The Effect of The Mediating Variable on The Dependent Variable

Finally, the study investigated the impact of the intermediate variable, relationship quality, on the urban public service quality as the dependent variable, taking into account the influence of the independent variable, interaction behaviour. The regression analysis reveals significant results for both interaction behaviour and relationship quality with regression coefficients of 0.318 and 0.198, respectively. These coefficients are found to be statistically significant at a 0.00 level, signifying a positive and substantial association between interaction behaviour, relationship quality, and urban public service quality. This suggests that interaction behaviour and relationship quality contribute positively to the quality of urban public services, thus implying a partial mediation effect. The formulated regression equation expressing the quality of public services is as follows: y (quality of public services) = 4.085 + 0.318*interaction behaviour + 0.198*relationship quality + ϵ (Tables 22 and 23).

Table 22. Tests of the Effect of the Mediating Variable on the Dependent Variable

Model	Non standardized coefficient		Standard coefficient	t	Significance
	B	Standard error	Beta		
(Constant)	4.085	1.206		3.386	0.001
Interactive behaviour	0.318	0.055	0.284	5.760***	0.000
R^2	0.198	.098	.600	12.175***	.000
Adjust R^2	0.738				
F-value	0.736				
Model	28.46***				

Note: *p < 0.05; **p < 0.01; ***p < 0.00.

Table 23. Summary of Intermediation Effectiveness Measurement Results

Term	Symbol	Effect relationship	Effect value	BootLLCI	BootULCI	Proportion of Effect	t-value	p-value	Inspection conclusion
Interactive behaviour⇒Relationship quality⇒ Public service effectiveness	a*b	Indirect effect	0.586	0.433	0.614	64.82%	12.753***	0.000	Partial mediation
Interaction behaviour⇒Relationship quality	a	X=>M	0.489	0.463	0.514		37.512***	0.000	
Relationship quality⇒Public service effectiveness	b	M=>Y	1.198	1.005	1.391		12.175***	0.000	
Interactive behaviour⇒Public service effectiveness	c'	Direct effect	0.318	0.21	0.426	35.18%	5.76***	0.000	
Interactive behaviour⇒Public service effectiveness	c	Total effect	0.904	0.843	0.965		28.887***	0.000	

Note 1: NoteBootLLCI refers to the lower limit of the 95% interval of Bootstrap sampling; BootULCI refers to the upper limit of the 95% interval of Bootstrap sampling; bootstrap type: percentile bootstrap method. Note 2: *p<0.05; **p<0.01; ***p<0.00.

Utilizing the Amos23.0 software for mediation analysis employing the bootstrap sampling methodology consisting of 5000 samples, the findings indicate that the direct impact of interactive behaviour on public service efficacy, alongside the mediating influence of relationship quality, yields a bootstrap 95% confidence interval wherein the interval limits do not encompass 0. In essence, interactive behaviour exerts a mediated influence on public service efficacy through the lens of relationship quality, with the direct effect constituting 35.18% of the total impact, while the mediating effect contributes a noteworthy 64.82%. This delineation denotes a state of partial mediation, thereby validating the hypothesis at hand.

4-6-Analysis of Moderating Effects

Public service effectiveness was employed as dependent variable, quality of relationship as independent variable, external environment as moderating variable (Table 24).

Table 24. Moderating Effects

		Model 1	Model 2	Model 3
	Constant	45.591** (181.908)	45.591** (228.122)	45.424** (184.510)
Independent variable	Relationship quality	0.692** (33.790)	0.508** (6.052)	0.516** (6.129)
Adjusting variables	External environment		0.843** (16.048)	0.847** (16.097)
Interaction term	Relationship quality * External environment			0.005 (1.163)
	Sample size	450	450	450
	R^2	0.718	0.821	0.822
	Adjust R^2	0.718	0.82	0.821
	F value	141.76***	26.57***	85.37***
	$\triangle R^2$	0.718	0.103	0.001

Note 1: Dependent variable=public service effectiveness. Note 2: *p<0.05; **p<0.01. The t-value in parentheses

When considering the independent variable as relationship quality and the dependent variable as public service effectiveness in a regression analysis, the obtained coefficient for relationship quality is 0.692, signifying statistical significance at the standard 0.05 level. This suggests that relationship quality exerts a notable positive impact on public service effectiveness. Upon introducing the external environment as an additional independent variable into the model, the regression coefficients for relationship quality and external environment are found to be 0.508 and 0.843 respectively, both exhibiting statistical significance at the 0.05 level. This implies that both relationship quality and external environment are associated with a significant positive influence on public service effectiveness. Furthermore, the inclusion of an interaction term in the regression model, derived as the product of relationship quality and the external environment post-centring, reveals a regression coefficient of 0.005, which is statistically significant at the 0.05 level. This result indicates that the external environment plays a positive moderating role in the relationship between relationship quality and public service effectiveness (Table 25). In summary, the relationship between relationship quality and public service effectiveness can be expressed as follows: Y (Public service effectiveness) = 0.516*Relationship quality + 0.005*(Relationship quality*External environment) + 0.847 *External environment + ϵ.

Table 25. Simple Slope Analysis of Moderator Variables

Adjust variable level	Regression coefficient	Standard error	t	p	95% CI	
Average value	0.516	0.084	6.129***	0.000	0.351	0.681
High level (1SD)	0.554	0.093	5.971***	0.000	0.372	0.736
Lowlevel (-1SD)	0.478	0.088	5.444***	0.000	0.306	0.65

Note 1: ***p<0.00

Utilizing the AMOS 23.0 software, it was found that the external environment exerts a beneficial moderating influence on the relationship between relationship quality and the effectiveness of public services. Subsequent simple slope analysis of this moderating effect reveals that both high and low levels of the external environment significantly moderate this relationship. Specifically, the high level of the external environment (r=0.554) demonstrates a more pronounced moderating effect on the relationship between relationship quality and public service effectiveness compared to the low level of the external environment (r=0.478). These findings confirm the validity of the hypothesis.

5- Conclusions

5-1- The Important Impact of Interactive behaviour on the Quality of Urban Public Services

The research findings indicate that effective interactive behaviour enhances trust, cooperation, and reciprocal relationships, thereby improving the quality of public services. This aligns with previous studies, which emphasize that interactive behaviour—particularly communication processes, mutual exchanges, and collaborative experiences—is essential for strengthening and maintaining supplier relationships [71].

1) Communication processes: Clear, timely, and open communication reduces misunderstandings while fostering mutual trust and cooperation [72]. Transparent communication minimizes service uncertainty, enabling suppliers to better adjust their services to meet demand, ultimately improving service quality and efficiency.

2) Mutual exchange: The two-way sharing of resources, knowledge, and feedback strengthens relationships and creates a cooperative environment [73]. This exchange not only enhances relationship quality but also helps address gaps in urban public services, ensuring service relevance and effectiveness.

3) Collaborative experience: Positive collaboration builds strong trust, forming a foundation for future partnerships [74]. Long-term relationships enhance reliability and competence, contributing to overall service quality improvement.

5-2- Relationship Quality Plays an Important Mediating Role

Research indicates that relationship quality plays a crucial mediating role between interactive behaviour and the quality of urban public services. This aligns with previous studies, which suggest that relationship quality is fundamental to effective cooperation among multiple public service providers, particularly when addressing complex challenges [75].

Interactive behaviours serve as key antecedents of relationship quality. Effective communication, mutual respect, and collaboration foster the core dimensions of trust, commitment, and cooperation [76]. Transparent and frequent communication reduces information asymmetry, strengthens trust, and promotes cooperation [77]. Relationship quality transforms interactive behaviours into tangible service outcomes, amplifying their positive impact.

Beyond facilitating smooth interactions, relationship quality helps mitigate conflicts and align the objectives of different service providers. High-quality relationships foster mutual understanding and shared responsibility, reducing inefficiencies and enhancing service consistency [78]. Additionally, adaptability enables service providers to collaborate effectively in meeting public needs, thereby improving overall service quality [79].

Moreover, relationship quality strengthens trust among service providers, fostering innovation and long-term collaboration. Strong relationships encourage resource sharing, knowledge exchange, and the adoption of best practices, further enhancing the quality of urban public services. Trust develops through continuous interaction and shared outcomes [80].

5-3- The External Environment Plays a key Moderating Role

Research findings indicate that the external environment plays a critical role in moderating the relationship between relationship quality and the quality of urban public services. External factors such as higher-level support, regulatory frameworks, and public participation significantly influence interactions and cooperation among service providers, ultimately affecting service quality.

Higher-Level Support: Support from government authorities or leadership provides essential resources, guidance, and encouragement to facilitate collaboration and achieve positive outcomes [81]. This support strengthens service providers' capacity to meet public expectations, thereby enhancing service quality.

Regulatory Frameworks: Clear and well-defined regulations create a stable and predictable environment for service providers, reducing uncertainty and aligning their goals [82]. A robust regulatory framework fosters a shared understanding of service expectations, improves relationship quality, and ensures service delivery meets public needs.

Public Participation: Citizen involvement in decision-making processes promotes accountability and transparency among service providers while fostering a sense of shared responsibility [83]. Public participation not only helps service providers better understand community needs but also strengthens trust and cooperation among stakeholders, ultimately improving urban public service quality.

The findings of this study offer valuable insights for public management, particularly in enhancing urban public service quality. The results highlight the importance of fostering interactive behaviour among service providers, strengthening relationship quality, and optimizing the external environment. Policymakers should focus on these factors to improve service delivery, especially in complex multi-governance settings.

Despite its contributions, this study has several limitations. It primarily focuses on the interactions and relationship quality of urban public service providers, leaving room for future research to incorporate additional external variables, such as socioeconomic factors and cultural background, to enhance the study's universality. The impact of these factors should be examined through specific data collection and analysis, particularly to determine whether significant differences exist across various urban contexts in China. Additionally, the study's cross-sectional data analysis may not fully capture long-term changes and dynamic effects. Future research could employ longitudinal tracking to better understand these long-term impacts. A potential framework for such studies includes: (1) long-term data collection spanning years or decades, and (2) multi-wave data collection at different time points to observe changes over time. As urban public service provision increasingly relies on multi-party collaboration, the efficiency of such cooperation is expected to improve.

6- Declarations

6-1- Author Contributions

Conceptualization, S.Z. and C.K.; methodology, S.Z.; software, S.Z.; validation, S.Z., C.K., and Z.P.; formal analysis, S.Z.; investigation, S.Z. and Z.P.; resources, S.Z. and C.K.; data curation, S.Z.; writing—original draft preparation, S.Z.; writing—review and editing, S.Z. and Z.P.; visualization, S.Z. and Z.P.; supervision, C.K.; project administration, S.Z. and C.K. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6-4- Institutional Review Board Statement

IRB Certificate (Approval Number: WUEC-25-112-01).

6-5- Informed Consent Statement

Not applicable.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Questionnaire on the Cooperation of Multiple Suppliers in the Provision of Urban Public Services

Here is based on the independent variables, mediation variables, regulated variable, dependent variable measurement item design questionnaire (including one of the dimensions adapted from the adjustment variables: superior support measurement items, this dimension is adapted and rearrange), according to the Likert Scale, Very agree, slightly agree, not necessarily, slightly disagree, disagree with the five dimensions of five points (5,4,3,2,1).

Dear ladies and gentlemen:

This is a questionnaire about the mechanism of urban public service provision by multiple suppliers. This questionnaire was voluntarily completed and anonymous, and was used for academic research only.

Thank you very much for taking time out of your busy schedule to support our research, which is a survey study on the mechanism of urban public services, Multiple suppliers cooperating together to provide, Multiple suppliers refer to the government, enterprises, social organisations, colleges and universities, individual citizens and so on.

There is no right or wrong answer, please fill in the form according to your real thoughts, we will keep the information you fill in strictly confidential, thank you very much for your support and cooperation! Choose the answer you think is the most correct among the five scores of 5,4,3,2 and 1 corresponding to the five dimensions of Strongly Agree, Comparatively Agree, Not Certainly, Not Quite Agree and Disagree, and fill in the brackets; multiple or fewer choices will not be counted. (General basic public services include the construction of public infrastructure, education, science, culture, health care, basic sports activities for all, employment and social security services, etc.)

The first part is personal information, please fill in truthfully:

1. What is your gender

☐ Male ☐ Female

2. What is your age

☐ 21-30 years old

☐ 31-49 years old ☐ Above 50 years old

3 Your educational background is

☐ Undergraduate ☐ Master's degree and above

☐ Junior college ☐ Others

4. Your career is a

☐ Government employees ☐ employees of social organizations

☐ corporate employees ☐ Others

The second part is the main body of the questionnaire.

Please choose according to your real feelings at work and the following situation design, and tick √ on the corresponding number.

Note: 5= Strongly Agree; 4= Comparatively Agree; 3= Not Certainly; 2= Not Quite Agree; 1= Disagree.

Serial number	Item of question	5	4	3	2	1
1	You think the Multiple suppliers of public services can often communicate about the cooperation content					
2	Multiple suppliers of public service can timely respond to the ideas and needs of the other party when the cooperation					
3	Information exchange in cooperation with Multiple suppliers of public service					
4	Communication with Multiple suppliers of public service can effectively resolve conflicts					
5	In cooperation, different subjects can obtain many relevant resources and information					
6	The resources and information obtained in the cooperation are of great help to the different subjects					
7	If the partners encounter difficulties, we are willing to provide help within their capacity					
8	In cooperation, each party of Multiple suppliers is willing to share resources with partners					
9	In the cooperation, the Multiple suppliers cooperate with each other more often and are more stable					
10	In cooperation, the cooperation experience between Multiple suppliers is more pleasant					
11	In the cooperation, our cooperation is very happy					
12	In cooperation, we can deal with the contradictions between us very well					
13	In cooperation, we can all consider each other's interests					
14	In cooperation, no matter which party has a problem, we will solve it together					
15	In cooperation, we have a high degree of resource complementary					
16	In cooperation, we have invested a lot of financial resources, material resources and manpower in the cooperation					
17	In cooperation, we will actively cooperate with the actions of our partners					
18	You are satisfied with the terms or provisions of the relevant system clarifying the responsibilities of the parties to the public service supply cooperation					
19	You are satisfied with the relevant regulations and regimes guaranteeing the rights and interests of the parties involved					
20	In cooperation, the rights and interests of the weaker party or several parties can be guaranteed by the corresponding system					
21	In the cooperation, the public is highly motivated to participate in public services					
22	In cooperation, effective information channels have been established between the cooperative suppliers and the public					
23	In cooperation, the self-governing organizations of the community residents are relatively mature					
24	The policy objectives of the superior departments can serve and promote the efficient operation of public service supply cooperation					
25	The feasibility of policy implementation (including technical, political, economic and financial feasibility) is relatively high					
26	All stakeholders in public service supply cooperation have responded positively to the policy					
27	In order to ensure the implementation of the policy input of financial resources, material resources and manpower are very sufficient					
28	The effective interaction mechanism (long-term promotion mechanism, supervision mechanism, information collection and feedback mechanism) among various elements of the policy system is relatively perfect					
29	The policy content of the superior department has a relatively high degree of agreement with the process of cooperation activities (cooperative behavior)					
30	The difference in service quality and service level of basic public services between regions and between different groups is relatively small					
31	The time cost of obtaining public services is within the acceptable range					
32	The situation that public service facilities and equipment and basic public services meet the service needs is satisfactory					
33	You think the situation that public service personnel meet their service needs is satisfactory					

34	The degree to which the supply of public services meets the needs of citizens, meets the needs and suits the needs is satisfactory	
35	Residents' satisfaction with the adequacy of basic public services is relatively high	
36	The degree of access to public services for different types of people is equal (including different incomes, different geographical regions, different cultures, and different identities)	
37	Residents' satisfaction with the equality of basic public services is relatively high	
38	The price and cost of public services are relatively commensurate with the audience's ability to pay (suitable and equal)	
39	There are various ways and channels to obtain public service information	
40	You are satisfied with the frequency of using specific techniques of cooperation in the provision of urban public services by multiple suppliers	
41	You are satisfied with the popularity rate of technology in different scenarios of cooperative supply by multiple suppliers of urban public services	
42	You are satisfied with the maturity of technology in different scenarios of cooperation of multiple suppliers in the provision of urban public services (e. g. infrastructure construction	
43	You think that the effect of technology can improve the efficiency of the cooperation of multiple suppliers in the supply of public services	
44	You think technology can enhance the effect of improving the quality of service or product	
45	you think technology can improve problem-solving skills	
46	The technological proficiency of public service multiple suppliers is relatively high	
47	The coverage and effectiveness of technical training is relatively high	
48	You are satisfied with the ability of multiple suppliers of public service to cooperate in supplying technical support	
49	Data security measures are adequate:	
50	You are satisfied with the stability of the cooperative supply system of multiple suppliers in public services:	
51	You are satisfied with the privacy protection ability of the public service multiple suppliers cooperation supply technology	

52. The last question of the questionnaire: open-ended: What can local governments do to improve the efficiency and quality of public service supply?