

# Application of Fuzzy Servqual Method in Assessing the Quality of Commercial Apartment Services in Hanoi

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**Abstract:** The study aims to apply the Fuzzy SERVQUAL method to measure and evaluate the gap between customers' expectations and actual perceptions of the service quality of commercial apartments in Hanoi. With the survey of 260 customers in Hanoi, The results show that the three lowest-ranked indicators of perceptions include RES2 (ranked 25th), SEC1 (ranked 24th), and REL2 (ranked 23rd). The Three lowest-ranked indicators of expectation include SEC1 (Ranked 25th, RES2 (ranked 24th), and REL2 (ranked 23rd). In addition, the research has also shown that ranking of the gap between customer perceptions and expectations shows that the response has the most significant gap; ranked second is assurance and third is the two dimensions include empathy and security.

**Keyword:** Fuzzy SERQUAL, Service quality , commercial apartment, Hanoi

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## 1. Introduction

Vietnam is a developing country with rapid urbanization. The dense population concentration has created a massive demand for housing in urban areas. The high demand for housing and the narrowing of the land fund leads to the developing of high-rise apartment buildings as an inevitable and objective trend in urban areas in Vietnam. Housing businesses have been developing many multi-owner apartment buildings, including utilities, to maximize human life. By 2020, 34.4% of the total population of Vietnam will live in urban areas. The population density in big cities like Hanoi is 9,343 people/km<sup>2</sup>. Preliminary statistics show the country has about 5,000 apartment buildings, mainly in Hanoi and Ho Chi Minh City. However, the process of residents moving into apartment buildings has generated many inadequacies, affecting residents' confidence in the apartment living environment.

Apartment buildings are a new trend for the modern and dynamic life of the young generation[1]. In recent years, along with the rapid urbanization process, there have been more and more commercial apartment complexes with different segments in busy urban areas[2]. As a rule, when living standards are getting higher and higher, apartment buildings must simultaneously meet many different needs of the population, including the quality of the living environment, such as public security, demand for cultural activities, and community communication. In addition to comfortable apartments, there is also a public space in the apartment building. Organizing such public function spaces requires certain studies to ensure scientific and normative construction standards and follow the general development trend under national customs and other natural factors with specific characteristics of Vietnam[2]. The quality of apartment services is essential to maintain the operation of the building. The managers must be ensured through the commitment and efforts of the Apartment Management Board in regularly reviewing the quality of building operation services to bring residents satisfaction[3]. Therefore, the requirement to improve the provision of apartment building management services to support and maintain the general activities of the apartment complex becomes increasingly urgent. The reality of apartment building management poses an urgent need to study and assess residents' satisfaction with the quality of apartment building services in Vietnamese cities to improve management activities.

Measuring resident satisfaction in the apartment has received interest from housing policymakers and housing businesses. With the potential controversy often occurring around the management activities of apartment buildings, there have also been studies on people's satisfaction focusing on the quality of housing services in general[1]. The evidence shows a need for more research on the gap between perception and perceived value provided by the Building manager board. However, to ensure the satisfaction of residents living in apartment complexes, it is necessary to pay attention to the quality of services that apartment management organizations provide in more detail.

## 2. Literature review

According to [4], service quality is a tool to measure the gap between the service provided and the customer's expectations. [5]defines *service quality* as "the outcome of the customer's evaluation process by comparing their expectations with the service they experience." [6]developed a conceptual framework for service quality to demonstrate that "quality is a comparison between expectations and actual experiences," leading to customer satisfaction. Agreeing with this concept, [7] have defined *service quality* as a way to control

business processes to ensure overall customer satisfaction at all levels, increasing customer satisfaction. Increase competitive advantage for the company. Therefore, the establishment of a service quality measure is essential thing in several empirical and theoretical studies in the field of service marketing.

Service quality and satisfaction, although two different concepts are closely related in the study of services (Parasuraman et al. (1985). Service quality and customer satisfaction are topics discussed by many researchers over the past decades. Numerous studies on customer satisfaction in service industries have been carried out. Some authors believe that there is an overlap between service quality and customer satisfaction, so these two concepts can be used interchangeably. Previous studies have shown that service quality is the cause of customer satisfaction [8], [9]. The reason is that service quality is related to service delivery, while satisfaction can only be assessed after using the service.

The SERVQUAL model is a tool developed by Berry et al., (1988) that focuses on perceived quality. Although this model has some criticisms in terms of the nature and number of aspects, SERVQUAL is still rated as a correct and easy-to-use scale for managers. This model includes five essential elements: tangibility, reliability, responsiveness, assurance, and empathy. Tangibility indicates the presence of facilities, equipment, and personnel. *Reliability* is generally defined as the ability to reliably and accurately deliver the promised service. Responsiveness is the willingness to assist customers and provide prompt service. The level of assurance includes the knowledge and politeness of employees and the ability to instill confidence in customers. The empathic aspect is the care and concern for each customer. However, The results of the in-depth interview, most of the customers mentioned safety. Safety is also one of the 10 component factors of the SERVQUAL scale before being generalized and shortened by Parasuraman for all service areas.

Many of the studies in the literature use the extended SERVQUAL method to assess service quality in different systems. For example, Kang et al. proposed the E-S-QUAL model (extended version of SERVQUAL) to measure e-service quality in an e-commerce environment [10]. Baber studied the influence on customers' perception of the current and potential scope of doing business with the bank to determine the bank's performance using a modified model named E-SERVQUAL [11]. Aagja and Garg used an extended version of the SERVQUAL model called PubHosQual (public hospital service quality) to measure the perceived service quality of public hospitals in their studies [12]. [13] developed a criterion to evaluate the performance index of existing public transport systems based on the perceptions and expectations of bus users with the proposed TRANSQUAL model as an extension of the SERVQUAL model. [14] conducted a study on an expanded SERVQUAL model with two new criteria related to digital technology and the pandemic to assess the quality of public transport services. Many studies on apartment service quality have also been done, such as [15] used the Servqual model to analyze residents' satisfaction with apartment service quality. [16] also use the Servqual model to study apartment services in Malaysia. In Vietnam, [17] also used the Servqual model to study apartment service quality in Vietnam. However, these studies mainly evaluate the relationship of service quality components to people's satisfaction without assessing the gap between expectations and perceived value of service quality that customers receive from apartment management.

### 3. Method

#### 3.1. Research design

In order to build a comparable scale used for empirical research, the author discussed with two experts in the field of real estate and customers living in commercial apartments in Hanoi city. The opinions of the customers are recorded, and new findings are noted. In the following interviews, the overlapping of new ideas and additions to the component of the apartment service quality scale was checked based on the SERVQUAL scale of [4], [15], [17] The results of all participants in the discussion agreed with the set of scales given. The measurement questions are easy to understand and not duplicated. The scale and its origin are presented in Table 1.

Table 1 Variables and sources

Variable	Code	Indicators	Source
Reliability	REL1	When the apartment management promises to do something at a specific time, they will do it	[4], [15], [17]
	REL2	The apartment management shows a genuine interest in solving the problems	
	REL3	Trusted apartment management board	
	REL4	The apartment management provided the service on time as promised	
	REL5	The apartment management board performed the service right from the first time	
	REL6	The apartment management board should note that there will be no	

Variable	Code	Indicators	Source
		mistakes when providing services	
	REL7	The apartment management board strictly implements the commitments in the contract	
	REL8	Quickly contact the apartment management when needed	
Responsenes	RES1	The apartment management staff is always ready to help	[4], [15], [17]
	RES2	The apartment management staff is never too busy to respond to request	
	RES3	The staff of the apartment management board always work on time	
Tangible	TAN1	Apartment with modern equipment	[4], [15], [17]
	TAN2	The staff of the apartment management board is well dressed	
	TAN3	The campus around the apartment is green, clean, and airy	The author added
	TAN4	The facilities of the apartment building are suitable for the types of services they provide	
Assurance	ASS1	The behavior of the apartment management staff creates trust	[4], [15], [17]
	ASS2	The staff of the apartment management board is always welcoming to	
	ASS3	The apartment management board has specialized departments to answer questions	
	ASS4	The staff of the apartment management board has enough skills to perform the services	
Empathy	EMP1	The management of the apartment works at convenient hours for all customers.	[4], [15], [17]
	EMP2	The staff of the apartment management board understands the needs when living in the apartment.	
	EMP3	The apartment management board often maintains, and repairs damaged public facilities before request.	
Security	SEC1	The apartment management board always has a security guard on duty 24/7	Author added
	SEC2	The apartment management board often organizes propaganda and training in fire prevention and fighting skills	
	SEC3	The apartment management board takes measures to prevent theft in the apartment	

### 3.2. Sampling

The study surveyed 260 sample customers living in commercial apartments with a similar design, location, and especially similarity in the apartment buildings' price segment and price level in Hanoi from July to September, 2022. After removed the invalid question, the number of valid questionnaires is 226, accounting for 86.9% issued. The results of descriptive statistics of the study sample are shown in the following Table2.

Table 2 Descriptive statistics of the study sample

		Frequency	Percen
Gendle	Male	127	56.19
	Fenale	99	43.81
Age	Under 30 years old	16	7.08
	30 - 40 years old	79	34.96
	40 - 50 years old	89	39.38
	More than 50 years old	42	18.58

Income	Under 15 million/month	22	9.73
	From 15-24 million/month	96	42.48
	Over 24 million/month	108	47.79
<b>Total</b>		<b>226</b>	<b>100</b>

### 3.3. Fuzzy – SERVQUAL method

This study uses the formula presented by [18] and [19] as following steps:

Step 1 calculate the total score

Consider the fuzzy number  $A_{pin}$  as the service quality perception of the  $n$ th interviewer through the service quality of indicator  $i$ .

$$TA_{ei} = \sum_{1}^n A_{ein} \quad (1)$$

$$TA_{pi} = \sum_{1}^n A_{pin} \quad (2)$$

Where:

$TA_{ei}$  : Is the expectation of the overall service quality of the indicator  $i$

$TA_{pi}$  : Is the perception of the overall service quality of the indicator  $i$

$A_{ein}$  : Is the service quality expectation of the  $n$ th interviewer for indicator  $i$ .

$A_{pin}$ : Is the  $n$ th interviewer's perception of service quality for indicator  $i$ .

Step 2 mean calculation

$$MA_{ei} = \frac{TA_{ei}}{N} \quad (3)$$

$$MA_{pi} = \frac{TA_{pi}}{N} \quad (4)$$

Where:

$MA_{ei}$  : Is the expected mean value of service quality of the indicator  $i$

$MA_{pi}$  : Is the perception mean value of service quality of the indicator  $i$

Step 3 Calculate the gap between perceived value and expectation

Let the fuzzy number Gap be the service quality gap between expectations and perceptions of all interviewees for the service quality of the indicatori.

$$\text{Gap} = MA_{pi} \ominus MA_{ei} \quad (5)$$

The integral mean method was developed by [20] to synthesize fuzzy numbers and is calculated as formula (6)

$$P(A) = 1/6(a+4b+c) \quad (6)$$

Table 3.Variables and functions

Linguistic variable	Member Functions
Very poor	(1,1,2)
Poor	(1,2,3)
Normal	(2,3,4)
Good	(3,4,5)
Very good	(4,5,5,5)

## 4. Results

Cronbach's alpha method was used to test the internal consistency as well as the reliability of the data. The results show that all factors have Cronbach's alpha coefficient  $> 0.7$  and are accepted according to the recommendations of [21]

The study uses formulas (1) and (2) to calculate the expected and perceived value of the apartment service quality of indicator  $i$  for all customers participating in the survey. The results are shown in Table 4, showing the fuzzy set scores on perceived value, expectation, and the gap between perception and expectation.

Table 4. Fuzzy score of perception and expectation of apartment service quality

Indicators	Peceived Value			Expected value			Fuzzy gaps		
	l	m	u	l	m	u	l	m	u
<b>REL</b>	2.55	3.50	4.43	2.59	3.61	4.54	-1.98	-0.10	1.84
REL1	2.32	3.31	4.19	2.34	3.39	4.35	-2.04	-0.89	1.85
REL2	2.28	3.26	4.23	2.30	3.35	4.32	-2.04	-0.96	1.93
REL3	2.67	3.61	4.54	2.70	3.70	4.63	-1.96	-0.93	1.85
REL4	2.68	3.62	4.52	2.70	3.70	4.59	-1.91	-0.90	1.82
REL5	2.52	3.46	4.40	2.54	3.56	4.50	-1.98	-0.94	1.86
REL6	2.66	3.59	4.51	2.72	3.73	4.65	-1.99	-0.92	1.79
REL7	2.56	3.51	4.48	2.60	3.61	4.58	-2.02	-0.96	1.88
REL8	2.73	3.65	4.54	2.80	3.79	4.67	-1.94	-0.89	1.73
<b>TAN</b>	2.82	3.74	4.63	2.86	3.84	4.73	-1.91	-0.90	1.77
TAN1	2.83	3.74	4.66	2.88	3.86	4.76	-1.93	-0.91	1.77
TAN2	2.97	3.87	4.74	3.04	4.00	4.84	-1.87	-0.87	1.70
TAN3	2.65	3.59	4.52	2.67	3.67	4.59	-1.95	-0.92	1.85
TAN4	2.82	3.74	4.62	2.85	3.83	4.72	-1.89	-0.88	1.77
<b>ASS</b>	2.63	3.56	4.50	2.69	3.69	4.62	-1.99	-0.94	1.81
ASS1	2.57	3.53	4.50	2.61	3.63	4.60	-2.03	-0.97	1.89
ASS2	2.70	3.65	4.59	2.75	3.75	4.69	-1.99	-0.94	1.84
ASS3	2.55	3.48	4.39	2.65	3.66	4.55	-2.00	-0.91	1.74
ASS4	2.69	3.59	4.51	2.73	3.71	4.63	-1.94	-0.92	1.78
<b>EMP</b>	2.76	3.68	4.59	2.80	3.79	4.70	-1.94	-0.91	1.79
EMP1	2.65	3.57	4.49	2.71	3.71	4.62	-1.96	-0.92	1.78
EMP2	2.81	3.73	4.63	2.80	3.79	4.69	-1.88	-0.90	1.83
EMP3	2.82	3.74	4.66	2.88	3.86	4.78	-1.96	-0.92	1.77
<b>RES</b>	2.51	3.38	4.25	2.67	3.57	4.43	-1.91	-0.87	1.58
RES1	2.58	3.48	4.40	2.75	3.68	4.60	-2.02	-0.92	1.65
RES2	2.16	2.94	3.74	2.40	3.19	3.94	-1.78	-0.79	1.34
RES3	2.79	3.71	4.62	2.86	3.84	4.73	-1.94	-0.90	1.76
<b>SEC</b>	2.36	3.31	4.17	2.39	3.40	4.34	-1.98	-0.86	1.77
SEC1	2.06	3.00	3.73	2.06	3.07	4.05	-2.00	-0.72	1.66
SEC2	2.54	3.46	4.40	2.57	3.57	4.51	-1.97	-0.94	1.83
SEC3	2.50	3.45	4.36	2.55	3.56	4.47	-1.97	-0.91	1.82

Formulas (3) and (4) are used to calculate the mean value of service quality expectations and perceptions from all survey participants on indicator i. Formulas (5) and (6) calculate the service quality gap between

expectations and perceptions. Table 4 shows the mean value and ranks the criteria reflecting the service quality of the apartment in terms of the average value and the gap between customers' perceptions and expectations.

Table 5 Indicators ranking of the SERQUAL model

Indicators	Percived	Ranking	Expectation	Ranking	Gap	Ranking
REL1	3.29	22	3.38	22	-0.09	16
REL2	3.26	23	3.34	23	-0.08	20
REL3	3.61	10	3.69	12	-0.08	20
REL4	3.62	9	3.68	13	-0.07	23
REL5	3.46	19	3.54	20	-0.08	20
REL6	3.59	11	3.72	9	-0.13	4
REL7	3.52	16	3.6	18	-0.09	16
REL8	3.64	8	3.77	7	-0.13	4
TAN1	3.74	2	3.85	2	-0.1	10
TAN2	3.87	1	3.98	1	-0.11	9
TAN3	3.59	11	3.66	15	-0.07	23
TAN4	3.73	4	3.82	5	-0.09	16
ASS1	3.53	15	3.62	17	-0.09	16
ASS2	3.65	7	3.74	8	-0.1	10
ASS3	3.48	17	3.64	16	-0.16	3
ASS4	3.59	11	3.7	10	-0.1	10
EMP1	3.57	14	3.7	10	-0.13	4
EMP2	3.73	4	3.78	6	-0.05	25
EMP3	3.74	2	3.85	2	-0.12	7
RES1	3.48	17	3.68	13	-0.2	2
RES2	2.94	25	3.18	24	-0.24	1
RES3	3.71	6	3.83	4	-0.12	7
SEC1	2.97	24	3.07	25	-0.1	10
SEC2	3.46	19	3.56	19	-0.1	10
SEC3	3.45	21	3.54	20	-0.1	10

The results in Tables 4 and 5 show that the gap between perception and expectation about the quality of commercial apartment services is primarily negative (-). This result shows that the quality of commercial apartment services has yet to meet customers' satisfaction using commercial apartments. Since this is a comparison between customers' perceptions and expectations, this gap may be high since customers' expectations tend to have higher expectations for apartment service quality. Relative to the level of demand. From the research results in Table 4, the ranking order of the service quality indicators of commercial apartments has been determined.

For the perception, the ranking order of the indicators is as follows: ranked first in the new commercial apartment service quality indicators is TAN2, "Apartment management staff are well-dressed," standing together. The second ranking is the TAN1 indicator, "Apartment with modern equipment," and the EMP3 indicator, "Apartment management often maintains and repairs damaged public equipment before being recommended by you. recommendation". The results show the lowest ranking include RES2 "The apartment management shows a genuine interest in solving problems" and SEC1 "Apartment management always has a security guard on duty 24/24h" are ranked 25th and 24th and REL2 "the general management demonstrate a genuine interest in addressing the impediment" is ranked 23rd .

As for expectations, the research results show that the three highest-ranked indicators belong to the TAN1 "Apartment with modern equipment" (ranked first), and the two indicators rank as second include TAN2 "Apartment management staff are well dressed" and EMP3 "Apartment management often maintains, and repairs damaged public facilities before being asked by you". Meanwhile, the three lowest-ranked indicators include SEC1, "Apartment management always has a security guard on duty 24/24h" at position 25, RES2, "When you encounter obstacles, the apartment management show a genuine interest in solving the obstacle" 24th and REL2, "When you have a problem, the management demonstrates a genuine interest in solving the obstacle" at 23.

For ranking the gap between perception and expectation, results show that the indicator with the most significant distance and ranked at number 1 is the RES2 indicator, "Apartment management staff is never too busy to respond to request". Ranked in second place is the RES1 indicator, "Apartment management staff are always ready to help you," and in third place is the ASS3 indicator, "The apartment management has specialized departments to answer questions". Indicators with the shortest gap between perception and expectation include: The 25th is the EMP2 indicator. "The staff of the apartment management board clearly understand your needs when living in the apartment building" the 23rd position has two indicators, including REL4, "The apartment management provided the service on time as they promised," and TAN3, "The campus around the apartment is green and clean and airy".

Table 6. Variables ranking of SERVQUAL model

Variables	Percived	Ranking	Expectation	Ranking	Gap	Ranking
REL	3.5	4	3.59	4	-0.09	5
TAN	3.73	1	3.83	1	-0.09	5
ASS	3.56	3	3.67	3	-0.11	2
EMP	3.68	2	3.77	2	-0.1	3
RES	3.38	5	3.56	5	-0.18	1
SEC	3.29	6	3.39	6	-0.1	3

Table 6 shows the ranking of the criteria reflecting the quality of commercial apartments of customers with the order of the top 3 criteria as follows, in terms of perception: ranking: The most important is the criterion of tangible means, the second is the criterion of empathy, and the third is the criterion of assurance. Meanwhile, for expectations, ranked first, second, and third are tangible, empathy, and assurance criteria. Thus, it can be seen that there is no change in the ranking of the criteria between customers' expectations and perceptions.

In addition, Table 6 also shows the order of ranking the gap between perception and expectation of the criteria reflecting the quality: the response has the most significant gap, second is the assurance criterion, and the third is the empathy and safety criteria.

### Discussion

The research results show that the gap between the actual perception and the customer's expectation about the service quality of the commercial apartment building is ranked the highest on the criteria related to empathy, the trust of the apartment management keeping promises as well as understanding and capturing the needs of residents, this result consistence with [15]–[17]. It shows that the capacity of the management board of commercial apartment buildings has changed positively, and training and professional improvement activities for these objects have been paid attention to and invested in [2], [22]. Besides these two criteria, the criterion of the surrounding area of the commercial apartment is also highly appreciated make the contribution of this research. The results show that the investment project owners and the management of the commercial apartment building have paid attention to the living space around the apartment, and the grounds have been adequately invested in meeting the needs of the residents.

However, the research results show that a large gap between customers' actual perceptions and expectations requires commercial apartment management boards to have solutions to improve the reception of information and process information in a scientific and timely manner to satisfy the needs of receiving feedback. Especially in the context of current scientific and technological development, the application of software to solve these problems is quite convenient and practical.

## 5. Conclusion

The purpose of the study is to apply the Fuzzy set method to assess the gap between customers' expectations and actual perceptions of the service quality of commercial apartments. The survey results of 260 customers who are residents of several commercial apartments in Hanoi show that the indicators in the three criteria of trustworthiness, empathy, and tangible have a small gap. Most of all, it shows that the response level of these indicators has the highest level of customer expectation. In other words, these are the most satisfied indicators by customers. Besides, the research has also shown that the criterion has the most significant gap between the actual perception and the customer's expectation. There are two indicators belonging to the criterion of responsiveness and one indicator belonging to assurance. The result shows that meeting customers' expectations for three indicators is necessary to have solutions to improve.

Academically, the research has shown a specific contribution of the service quality indicators of commercial apartments using additions to the criteria. The study also confirmed the effectiveness and science of the fuzzy-set method in studying customer satisfaction with the quality of commercial apartment services through customer evaluation by comparing actual perception and expectation.

The research results the urgency for improving the quality of the service receiving feedback from customers, as well as skills in information processing and effective feedback mechanism. It is also the implementation of training on knowledge and skills for the management board and especially the investment in the application of information technology equipment in receiving and processing information. From the research results, it is possible to apply it to management activities and improve the quality of commercial apartment services.

The apartment investor needs to implement a vertical integration strategy and invest in the apartment service sector by setting up a department - specialized in managing and providing professional services and recruiting and training staff to provide better services. Along with that, investment in the quality of commercial apartment project service providers needs to be considered. Employees are the leading resource throughout the process of transferring and performing services, and the staff's style, attitude, professional qualifications, and communication skills largely determine the service's quality. , thereby gaining the trust of customers. The investor should have a policy of training and improving the professionalism of employees, awakening employees' awareness of working attitudes and professional ethics. In addition, the investor must also have a reasonable incentive policy for the staff who are providing satisfactory services of the apartment, through which the staff will be more enthusiastic and serve customers enthusiastically.

Although there have been academic and applied contributions to management, the research still has limitations as the study was only conducted in Hanoi with commercial apartments. The research method only stops at comparing the average value through the Fuzzy set method, so the ranking still needs to be clarified. Further studies may be more extensive with other cities across the country, need to survey other commercial apartment segments in the market, and use some other fuzzy tools to clarify research results such as FAHP, TOPSIS.

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