Assessing municipal solid waste collection service quality in a developing country context: A case study of Nha Trang, Vietnam

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Abstract:

Municipal solid waste management in developing countries, particularly in Nha Trang, Vietnam, faces significant challenges due to rapid urbanization and limited resources. This study evaluates service quality in waste collection using the SERVPERF model, based on a survey of 242 respondents analysed with Statistical Package for the Social Sciences (SPSS). Reliability was confirmed through Cronbach's alpha, while exploratory factor analysis identified two main factors influencing service quality: professionalism and a serving-people spirit. However, the linear regression model explained only a small portion of the variance in perceptions of service quality. The findings underscore the importance of professionalism and community-oriented service in shaping public satisfaction. While the study's explanatory power is limited, it provides insights for policymakers aiming to improve waste management practices. Future research should involve larger, more diverse samples and refined measurement models, as well as comparative analyses across different customer segments to enhance understanding and support improvements in waste collection services in Vietnamese urban areas.

Keywords: **municipal solid waste collection, public satisfaction, service quality assessment, Vietnam.**

Classification numbers: **2.2, 7**

1. Introduction

Municipal solid waste management (MSWM) in urban areas of developing countries faces several challenges due to the rapid increase in both the quantity and hazardous level of waste generated [1, 2]. Industrial over-production, population growth, and intense urbanisation are considered the leading causes of this situation [3, 4]. The growing urban population in Vietnam has led to significant environmental issues, particularly in the realm of waste management. Despite the collection of 83-85% of generated waste in urban areas, the remaining 15-17% is discharged into the environment, causing persistent pollution. Landfilling remains the predominant method of treating urban domestic solid waste, with approximately 34%

of municipal solid waste (MSW) being directly buried in urban areas [5, 6]. These negative indicators underscore the urgent need to reassess and improve the urban domestic solid waste management system in Vietnam.

Nha Trang, a coastal city in Khanh Hoa province, Vietnam, faces specific challenges in managing its growing MSW. The city's rapid urbanisation, tourism growth, and limited resources have put a strain on its waste collection and management infrastructure. Measuring service quality is a crucial step for authorities and contractors to gather and analyse information about citizens' needs, perceptions, and satisfaction regarding MSW collection services. By understanding the determinants of service quality,

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policymakers can develop targeted interventions to enhance the efficiency and sustainability of waste management practices in Nha Trang.

This study aims to assess the quality of MSW collection services in Nha Trang by applying the SERVPERF model, a widely used service quality measurement tool. The specific objectives are to: i) Identify the key aspects that reflect the quality of MSW collection service by adapting the SERVPERF model to the local context; ii) Measure participants' assessment of service quality and determine the most essential aspects influencing their perceptions; iii) Develop a regression model to explain the variance in MSW collection service quality based on the identified aspects.

Evaluating service quality is essential for proposing solutions to operate and improve the urban domestic solid waste management system sustainably. The findings of this study will contribute to the growing body of literature on MSWM in developing countries and provide valuable insights for policymakers and service providers in Nha Trang and other Vietnamese cities facing similar challenges. By identifying the determinants of MSW collection service quality and their relative importance, this research will support evidence-based decision-making and the development of targeted interventions to enhance public satisfaction and promote sustainable waste management practices.

The following sections of this paper will provide a background on service quality measurement models, describe the methods and materials used in the study, present the results of the statistical analyses, and discuss the implications of the findings for policy and practice. The conclusion will summarise the key findings and outline directions for future studies in this critical area of urban environmental management.

2. Background to the study

Service quality has been recognised as a crucial factor in the production and service provision of all organisations. The concept of service quality has evolved since the 1930s, with early pioneers such as W.E. Deming, J.M. Juran, and K. Ishikawa emphasising its importance in the manufacturing sector [7]. In the context of waste management, measuring service quality is essential for authorities and contractors to gather and analyse information about citizens' needs, perceptions, and satisfaction regarding MSW collection services. By understanding the determinants of service quality, policymakers can develop targeted interventions to enhance the efficiency and sustainability of waste management practices. To search for a scientific way to measure service metrics, A.P. Parasuraman, et al. (1988) [8] propose an unambiguous definition of service quality. The quality of service that A.P. Parasuraman and colleagues refer to is the quality perceived by the customer or the customer's assessment of the excellence or superiority of a service business [9]. Service quality has many different definitions depending on the research object and the research environment to determine the organisation's service quality. Therefore, defining service quality is vital in setting development goals and orienting the service supplier to best promote its strengths.

Various methods have been proposed to assess service quality, each with its advantages and limitations (Table 1). Gummesson argues that since service is intangible, quality is not directly observable, and evaluating service quality based on user perceptions is considered a reasonable approach. This theory is based on studies of the satisfaction that service users perceive through the service gaps expected and received. U. Lehtinen (1982) [10] suggests that service quality must be assessed on two aspects: (1) the service delivery process and (2) the results of the service. C. Grönroos (1984) [11] also proposes two components of service quality: (1) technical quality, referring to what the customer receives, and (2) functional quality, referring to the interpretation of the service provided.

Nevertheless, it would be a significant shortcoming if not to mention the outstanding contribution of A.P. Parasuraman, et al. (1988, 1991) [8, 12]. They developed the SERVQUAL model, which is considered a typical scale of service quality, value, and reliability,

Table 1. Methods for assessing service quality.

Method	Advantage	Disadvantage
Grönroos' model	It is the first attempt to measure service quality. It is capable of linking service quality assessment with service users through their perceptions of technical and functional quality.	There are no specific evaluation criteria for measuring technical quality and functional quality yet.
SERVQUAL	It is widely applied in many different service areas. It is capable of connecting the assessment of library service quality with service users. It is capable of identifying gaps between variables that affect the quality of services provided.	There is difficulty in measuring customer expectations. It is complicated for respondents to differentiate between expected and perceived quality. Its measurement procedure is quite time-consuming.
SERVPERF	Its measurement is unambiguous and straightforward.	It is incapable of reflecting the relationship between user expectation and the quality of service provided.

and can be applied to all types of services. The SERVQUAL model measures both perceived quality and expectation across five dimensions: tangibles, reliability, responsiveness, assurance, and empathy. However, the SERVQUAL scale has limitations in distinguishing between customer satisfaction and attitudes.

To address these limitations, J.J. Cronin Jr., et al. (1992) [13] introduced the SERVPERF model, which focuses on measuring perceived quality without considering the five components' expected quality or weighted rating. The SERVPERF model is derived from the SERVQUAL scale and shares the same observed components and variables. By measuring only perceived quality, the SERVPERF model reduces the complexity of the measurement process and has been widely adopted in various service sectors.

In the context of MSW management, several studies have investigated the measurement of MSW collection quality using various approaches. N.O. Opareh, et al. (2002) [14] and G. Bel, et al. (2003) [15] conducted early work on revealing the MSW collection service mechanism and the determinants of its quality. M.E. Kaseva, et al. (2005) [16] appraised solid waste collection following private sector involvement in Dar es Salaam, Tanzania. More recent studies have proposed sets of indexes to characterise the technological and economic aspects of waste collection systems in several cities [17-19]. These studies highlight the importance of sustainable and cooperative practices in MSW collection services and urban environment management.

Despite the growing body of literature on MSW collection service quality, there is still considerable ambiguity regarding the determinants of service quality in this context. The existing research on municipal solid waste (MSW) collection service quality in Vietnam highlights the need for a comprehensive understanding of service quality determinants. Studies in Hanoi [5] and Long An province [6] have identified user satisfaction, operational efficiency, and economic factors as key influences on service quality perceptions, aligning with the SERVPERF model's focus on performance measurement. One question that arises is whether the SERVPERF model is suitable for measuring MSW collection service quality. Additionally, there is a lack of significant research on measuring MSW collection service quality in Vietnamese municipalities. This study aims to address these gaps by assessing the suitability of the SERVPERF method for measuring MSW collection service quality in Nha Trang, Vietnam. The specific objectives are to identify the aspects that reflect the quality of MSW collection service by applying the SERVPERF model, measure participants' assessment of service quality, and determine the most essential aspects influencing their perceptions.

Evaluating service quality is crucial for proposing solutions to operate and improve the urban domestic solid waste management system sustainably. The findings of this study will contribute to the growing body of literature on MSW management in developing countries and provide valuable insights for policymakers and service providers in Nha Trang and other Vietnamese cities facing similar challenges. By identifying the determinants of MSW collection service quality and their relative importance, this research will support evidence-based decision-making and the development of targeted interventions to enhance public satisfaction and promote sustainable waste management practices.

3. Methods and materials

3.1. Research methods

This study employed a quantitative research approach to assess the quality of municipal solid waste (MSW) collection services in Nha Trang, Vietnam. The research process involved adapting the SERVPERF model to the context of waste collection services, developing a questionnaire survey, collecting data from local residents, and conducting statistical analyses to identify the determinants of service quality.

3.2. Questionnaire development and data collection

A structured questionnaire was developed based on the SERVPERF model, which measures service quality across five dimensions: tangibles, reliability, responsiveness, assurance, and empathy. The original 22 variables of the SERVPERF model were adapted to suit the specific context of MSW collection services in Nha Trang. Through a thorough literature review and expert consultation, a set of 10 variables was selected to represent the five dimensions of service quality (Table 2).

The questionnaire was distributed to 250 respondents, including both temporary and permanent residents of Nha Trang, using a convenient sampling method. The sample size was determined based on the statistical significance and available resources for the study. Considering the statistical significance, a

Table 2. Dimensions and indicators used in data collection.

Dimension	Indicator	Description	Variable code
Tangibles	Vehicles	Waste collection vehicle and equipment are in good condition	TA1
	Facilities	Temporary garbage storage facilities are in good condition	TA2
	Convenient distance	Waste collection and temporary storage places are located in convenient locations	TA3
Reliability	Promised service	Waste collection is carried out consistently	LI1
	Maintenance	Waste collection is carried out meticulously	LI2
Responsiveness	Promptness	Waste collection is always carried out on time as planned	SP1
	Helpfulness	Waste collection in places that arise unexpectedly is always carried out in a timely manner	SP2
	Waiting time	Processing time for unexpected requests is reasonable	SP3
Assurance	Respect	The service provider always offers a variety of means to listen to citizens' opinions	AS1
Empathy	Caring	The service provider always cares and understands citizens' expectations	EM1
Perceived quality	Customer satisfaction	The citizens are satisfied with the waste collection services	PQ1

sample size of 250 is considered adequate for EFA and linear regression, as it satisfies the common rule of thumb of having at least 10 observations per variable [20, 21]. In this study, with 10 observed variables, a sample size of 250 exceeds the minimum requirement for statistical power. However, because a convenience sample was used instead of random sampling, the findings may not be generalisable to the broader population, as this approach can introduce bias and limit the external validity of the results.

Data collection was conducted over a period of two weeks in July 2023. A survey team of 12 members was assigned to collect samples in specific wards to avoid overlapping and ensure representative coverage. Each questionnaire included the respondent's personal information and telephone number, allowing the team leader to verify the accuracy and quality of the collected data. Given the available resources for data collection, including the survey team of 12 members and the two-week data collection period, a sample size of 250 was deemed manageable and achievable. However, due to 8 responses missing certain fields of information, they were excluded, resulting in 242 samples being included in the analysis. This sample size allows for a representative coverage of the target population in Nha Trang, while also considering the practical constraints of the study.

Ethical considerations were taken into account during the data collection process. Respondents were informed about the purpose of the study, assured of confidentiality, and provided with the option to withdraw at any time. The study was approved by the Institute of Investment and Construction Management Review Board prior to data collection.

3.3. Statistical analysis

The collected data were processed using SPSS version 20.0. The internal consistency of the measurement scale was assessed using Cronbach's alpha coefficient, with a threshold of 0.6 or higher indicating acceptable reliability for a new concept under study.

EFA was conducted to identify the underlying constructs among the measured variables. The suitability of the data for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Factors were extracted using the principal component method, with significant factors having at least three items with coefficients higher than 0.350, eigenvalues greater than 1.41, and accounting for a minimum of 50% of the variance [22]. Promax rotation was applied to allow for correlated factors.

Linear regression analysis was performed to examine the relationship between the identified factors (independent variables) and the overall service quality (dependent variable). The regression model's explanatory power was assessed using the adjusted R-squared value, and the significance of the regression coefficients was tested at the 95% confidence level.

The results of the statistical analyses were interpreted in the context of the research objectives and existing literature on MSW collection service quality. The findings were compared with previous studies to identify similarities, differences, and potential contributions to the field.

4. Results and discussion

4.1. Reliability analysis of dimensions

The reliability of the measurement scale was assessed using Cronbach's alpha coefficient. Variables with item-total correlation less than 0.4 were disqualified. A scale with Cronbach's alpha coefficient of 0.6 or higher is considered acceptable for a new concept under study [23].

In this case, the Cronbach's alpha of 0.858 indicates sound measurement, and all observed variables have item-total correlation coefficients greater than 0.4 (Table 3). No variables were rejected that could make Cronbach's alpha greater than 0.858. This finding suggests a close relationship and uniformity among the items in each dimension, confirming that the scale used to measure service quality has relatively good internal reliability.

Table 3. The result of Cronbach's alpha coefficient test.

	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
TA1	30.78	69.825	.592	.843
TA2	31.05	70.993	.486	.851
TA3	31.04	69.382	.581	.843
LI1	30.58	73.164	.483	.851
LI2	30.76	70.723	.525	.848
SP1	30.78	70.020	.592	.843
SP2	30.85	70.711	.511	.849
SP3	31.27	65.009	.660	.836
AS1	31.40	64.157	.625	.839
EM1	31.52	63.516	.614	.841

The data in the table was extracted from SPSS analysis output window.

The Pearson item-total corrected correlations are presented in Table 4. All correlations are significant at the 0.01 level, as indicated by the double asterisks (**). Although there appears to be a correlation between the dependent and independent variables, the degrees of correlation are quite low.

Table 4. The Pearson item-total corrected correlations.

	PQ1
TA1	.423**
TA2	.224**
TA3	.344**
LI1	.445**
LI2	.372**
SP1	.350**
SP2	.257**
SP3	.440**
AS1	.319**
EM1	.298**

The data in the table was extracted from SPSS analysis output window.

Table 5. The Kaiser-Meyer-Olkin and Bartlett's test.

Kaiser-Meyer-Olkin measure of sampling adequacy		.859
Bartlett's Test of Sphericity	Approx. Chi-Square	904.075
	df	45
	Sig.	.000

The data in the table was extracted from SPSS analysis output window.

4.2. Exploratory factor analysis

EFA was conducted to reduce the number of observed variables and discover the fundamental factors in which groups of variables are interrelated. The sample size of 242 observations was more than twice the number of observed variables, meeting the theoretical requirements for factor analysis.

KMO measure of sampling adequacy was 0.859, indicating that the use of factor analysis techniques for this study is appropriate and reliable (Table 5). Bartlett's test of sphericity showed a significant correlation between the observed variables ($p<0.001$), further confirming the suitability of factor analysis.

The total variance explained by the extracted factors was 57.42%, satisfying the minimum requirement of 50% (Table 6). Two factors were extracted based on the Kaiser criterion (eigenvalues>1) and the scree plot.

The rotated component matrix (Table 7) revealed two distinct factors affecting waste collection service quality: professionalism (PRO) and diligent and serving-people spirit (DSP). Variables with factor loadings above 0.5 were considered significant contributors to their respective factors.

Table 6. Total variance explained.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4.363	43.629	43.629	4.363	43.629	43.629	3.312	33.122	33.122
2	1.379	13.791	57.420	1.379	13.791	57.420	2.430	24.298	57.420
3	.883	8.829	66.249						
4	.769	7.689	73.938						
5	.614	6.137	80.075						
6	.510	5.096	85.171						
7	.454	4.537	89.708						
8	.429	4.293	94.000						
9	.340	3.401	97.402						
10	.260	2.598	100.000						
Extraction method: Principal component analysis.									

The data in the table was extracted from SPSS analysis output window.

Table 7. Rotated component matrix.

	Component	
	1	*2*
TA1	.749	
SP1	.745	
TA3	.727	
SP2	.704	
LI2	.599	
LI1	.578	
TA2	.562	
EM1		.892
AS1		.851
SP3		.810

The data in the table was extracted from SPSS analysis output window.

Table 8. Model summary[b].

Model	R	R square	Adjusted R square	Std. error of the estimate	Durbin-Watson
1	.522[a]	.272	.266	1.088	1.944

a. Predictors: (constant), professionalism, spirit

b. Dependent variable: PQ1

The data in the table was extracted from SPSS analysis output window.

Table 9. ANOVA[a] and coefficients[c].

Model		Sum of squares	df	Mean square	F	Sig.			
1	Regression	105.746	2	52.873	44.692	.000[b]			
	Residual	282.750	239	1.183					
	Total	388.496	241						

a. Dependent variable: PQ1

b. Predictors: (constant), professionalism, spirit

Model		Unstandardised coefficients		Standardised coefficients	t	Sig.	Collinearity statistics	
		B	*Std. Error*	*Beta*			*Tolerance*	*VIF*
1	(Constant)	.915	.296		3.088	.002		
	spirit	.173	.056	.198	3.115	.002	.751	1.331
	professionalism	.570	.092	.394	6.184	.000	.751	1.331

c. Dependent variable: PQ1

4.3. Linear regression

Linear regression analysis was performed to examine the relationship between the identified factors (independent variables) and the overall service quality (dependent variable, PQ1). The regression model is defined as follows:

$$PQ1 = \beta_1 * PRO + \beta_2 * DSP + \beta_0$$

The regression results (Table 8) showed that the model explained 26.6% of the variance in the dependent variable (adjusted $R^2 = 0.266$). While this explanatory power is relatively low, it is not uncommon in exploratory studies of complex social phenomena like service quality perceptions.

The ANOVA results (Table 9) confirmed the statistical significance of the regression model ($F_{(2, 239)} = 44.523$, $p < 0.001$). The regression coefficients for both professionalism ($\beta_1 = 0.57$, $p < 0.001$) and diligent and serving-people spirit ($\beta_2 = 0.173$, $p < 0.01$) were significant predictors of overall service quality. The final regression equation can be written as:

$$PQ1 = 0.57 * PRO + 0.173 * DSP + 0.915$$

These findings suggest that professionalism has a stronger influence on service quality compared to diligent and serving-people spirit. However, it is important to acknowledge that the model only explains a portion of the variance in service quality perceptions, indicating the presence of other factors not captured in this study.

4.4. Discussion

The results of this study provide valuable insights into the determinants of municipal solid waste collection service quality in Nha Trang, Vietnam. The adapted SERVPERF model, with its five dimensions (tangibles, reliability, responsiveness, assurance, and empathy), proved to be a reliable and valid tool for assessing service quality in this context. The high Cronbach's alpha coefficient and significant factor loadings support the internal consistency and convergent validity of the measurement scale.

The identification of professionalism and diligent and serving-people spirit as key factors influencing service quality perceptions aligns with previous research highlighting the importance of technical competence and customer-oriented attitudes in service delivery. The stronger impact of professionalism on overall service quality suggests that citizens place greater value on the tangible aspects of waste collection, such as the condition of vehicles and facilities, timeliness, and consistency of service. This finding underscores the need for waste management authorities and service providers to prioritise investments in infrastructure, equipment maintenance, and staff training to enhance service quality.

While diligent and serving-people spirit had a smaller effect on service quality perceptions, its significance should not be overlooked. This factor encompasses the empathy and responsiveness dimensions of the SERVPERF model, highlighting the importance of understanding and addressing citizens' needs and concerns. Waste management authorities should foster a customer-centric culture among service providers, encouraging proactive communication, prompt issue resolution, and a caring attitude towards the community.

The relatively low explanatory power of the regression model suggests that other factors not included in this study may influence citizens' perceptions of waste collection service quality. Future research could explore additional variables, such as environmental awareness, public participation,

and socio-demographic characteristics, to develop a more comprehensive understanding of service quality determinants. Qualitative methods, such as interviews and focus groups, could provide deeper insights into citizens' experiences and expectations regarding waste collection services.

The findings of this study have important implications for policymakers and waste management practitioners in Nha Trang and other Vietnamese cities facing similar challenges. By identifying the key factors driving service quality perceptions, authorities can allocate resources more effectively and design targeted interventions to enhance public satisfaction. For example, investing in modern waste collection equipment, optimising collection routes, and providing regular training for service personnel could significantly improve professionalism and, consequently, overall service quality. However, it is important to exercise caution with this proposal, as the study's small sample size may not yet be representative of the broader population in Nha Trang. Further research with a larger and more diverse sample is necessary to ensure that the findings are applicable and to inform effective policy decisions.

Moreover, the adapted SERVPERF model used in this study can serve as a valuable tool for continuous monitoring and evaluation of waste collection service quality. Regular assessments using this model can help authorities track progress, identify areas for improvement, and benchmark performance against other cities or service providers. This data-driven approach to service quality management can contribute to the development of more sustainable and responsive waste management systems in Vietnam.

To sum up, this study contributes to the growing body of literature on MSWM in developing countries by providing empirical evidence on the determinants of service quality in the context of Nha Trang, Vietnam. The findings highlight the importance of professionalism, diligent, and serving-people spirit in shaping citizens' perceptions of waste collection service quality. While the explanatory power of the model is limited, it offers

evidence for future research and provides actionable insights for policymakers and practitioners seeking to enhance public satisfaction and promote sustainable waste management practices.

5. Conclusions

This research sought to evaluate the effectiveness of municipal solid waste collection services in Nha Trang, Vietnam, by employing the SERVPERF model. The findings provide valuable insights into the determinants of service quality and the applicability of the SERVPERF model in this context. The adapted SERVPERF scale, with its five dimensions (tangibles, reliability, responsiveness, assurance, and empathy), demonstrated good internal reliability, as confirmed by the Cronbach's alpha coefficient test. Exploratory factor analysis revealed two key factors influencing waste collection service quality: professionalism and diligent and serving-people spirit. The regression results showed that professionalism had a stronger impact on overall service quality compared to diligent and serving-people spirit. However, the regression model only explained a small portion of the variance in service quality perceptions, indicating the presence of other factors not captured in this study. The study contributes to the growing body of literature on MSWM in developing countries by providing empirical evidence on the determinants of service quality in the context of Nha Trang, Vietnam. The adapted SERVPERF model can serve as a starting point for future research and a tool for continuous monitoring and evaluation of waste collection services.

However, the study has several limitations that should be acknowledged. The sample size of 242 respondents may not be large enough to capture diverse perspectives, and the focus on a single city limits the generalisability of the findings. Additionally, the set of observational variables used in the SERVPERF model may need refinement to better fit the context of waste collection services. Future research should address these limitations by utilising larger, more diverse samples across multiple Vietnamese cities and incorporating qualitative methods to gain a richer understanding of service quality determinants. Developing enhanced measurement models tailored specifically to waste collection services could also improve explanatory power. Comparative analyses between different customer segments, service providers, and longitudinal studies would provide valuable insights.

The findings of this study have important implications for policymakers and waste management practitioners in Nha Trang and other Vietnamese cities. By identifying the key factors driving service quality perceptions, authorities can allocate resources more effectively and design targeted interventions to enhance public satisfaction. The adapted SERVPERF model can be used for continuous monitoring and evaluation of waste collection services, supporting evidence-based decision-making and driving progress toward sustainable waste management practices. In conclusion, this study represents an important step toward understanding the determinants of municipal solid waste collection service quality in Vietnam. While the explanatory power of the current model is limited, it provides evidence for future research and highlights the need for more comprehensive and context-specific measurement tools. By addressing the identified limitations and research gaps, policymakers and practitioners can work towards developing superior, sustainable waste collection systems that maximise public satisfaction and contribute to the overall well-being of Vietnamese urban areas.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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