ANALYZING PASSENGER'S SATISFACTION ON RECENTLY LAUNCHED BUS SERVICES IN DHAKA CITY THROUGH DISCRETE CHOICE MODEL

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ABSTRACT

In Dhaka, the bus transportation system deals with the issues of insecurity, lack of dependability, inefficiency, and challenges in managing the daily mobility needs of its substantial populace. As a result, it becomes imperative to assess the effectiveness of bus service quality (SQ) through the lens of customer experiences. Despite numerous studies delving into the performance of public transportation systems in Bangladesh, there has been limited focus on comprehending how service quality attributes intersect with passenger satisfaction. In this context, this paper undertakes a comparative examination of user perceptions surrounding two recently launched public transport services in Dhaka city. To unravel the relationship of key indicators, a discrete choice model has been used. Constructed from a comprehensive survey of 1140 questionnaires, which assessed passengers' travel experiences and feedback, the choice model serves as the analytical framework. The outcomes of the model analysis sort out the SQ of both Bus Service-1 (BS-1) and Bus Service-2 (BS-2). Particularly, the assessment indicates that BS-1 accumulates an overall rating of "good," while BS-2 attains a "satisfactory" rating, based on a spectrum of preference levels encompassing "excellent," "satisfactory," "good," and "poor." Pertaining to attributes of service, such as travel time, BS-1 receives a positive rating with a coefficient of 0.413, whereas BS-2's rating stands at 0.168. The analysis also accentuates waiting time and mode availability as pivotal contributors to passenger satisfaction. The study's conclusions offer transportation planners a valuable opportunity to formulate strategic transport policies and regulations aimed at elevating service quality to meet specific goals.

Keywords: *Service Quality (SQ), Public Transport, Discrete Choice Model, Transport Policies.*

1. INTRODUCTION

In the bustling metropolis of Dhaka, the heartbeat of public transit is the bus service. Navigating through the maze of congested streets, buses stand as the beacon of hope for efficient and sustainable transportation. But with the ever-increasing demand for public transport and the waning appeal of private modes, the challenge is set. Evaluating the performance of these buses becomes the pivotal concern for transit managers, especially for the new circular and semi-circular routes.

In developing countries, the inadequacy of transport facilities leads to frustrations—delays and unreliability tainting the user experience. The remedy? Enhancing the quality of bus services. Understanding the user's viewpoint becomes imperative to pave the way for improvement in this transport ecosystem. However, this task isn't one-size-fits-all, as user satisfaction dances to the tune of different situations.

Bangladesh has seen studies evaluating bus service quality, yet very few delve into the intricate web of user perceptions across various bus route types in Dhaka. This research seeks to employ statistical methods to unravel the nuances of influencing factors across these diverse routes. Capturing the essence of user perception is the cornerstone for effective transportation management.

2. LITERATURE REVIEW

Evaluating the performance of existing bus network structures has become a dominant pursuit in attracting new passengers. Recent years have witnessed multiple studies aimed at identifying the most suitable network structures for future implementation and design, with the adoption of circular and semi-circular network concepts in many urban centres.

Various methodologies—ranging from SERVQUAL techniques to structural equation models and regression analyses—have been employed to explore user preferences for service quality, particularly in developing countries. While effective, these techniques often yield complex analyses, raising concerns regarding heterogeneity. To address this, discrete choice models have emerged as a means to mitigate risks and ensure considerations of individual passenger preferences.

In the context of Dhaka city, research has illuminated the attributes associated with public service, revealing existing services as inefficient and non-responsive to user needs due to the authorities' neglect of major service attributes. Several passenger surveys have sought to create models linking user experiences with specific service parameters, highlighting concerns about travel cost, environmental impact, and the quality of transportation modes and waiting stations. Prioritizing these attributes has become a focal point for future service improvements, crucial for both transport managers and planners to retain and expand passenger demand.

Although several studies have addressed public transport service quality, a gap persists regarding research on various bus network service parameters. This study aims to identify the major service attributes of two distinct bus network systems, filling this void.

The literature review offers valuable insights. Redman et al. (4) explored service attributes conducive to shifting commuters from private vehicles to public transport, emphasizing the importance of service reliability and frequency. Ali (6) revealed varying bus service qualities across different areas of the city, influenced by factors like waiting times and service frequencies. Andreassen (7) delved into customer satisfaction across bus, train, and tram services, proposing improvements in areas such as traveling time, price level, and station layout.

Notably, studies have underlined the significance of reliability in commuting times, citing its correlation with stress-related measures. Comfort has also emerged as a crucial aspect of service quality in public transport, as highlighted by research in various locations, including Italy.

Understanding these factors—reliability, trip frequency, and travel time—remains pivotal, especially in the context of city bus services.

Ultimately, this study contributes to a deeper comprehension of passenger attitudes toward public transport, emphasizing the importance of comfort in these services and the need for continued exploration of service quality to enhance future service provisions.

3. STUDY BACKGROUND

For Dhaka, the bustling capital of Bangladesh, houses a staggering 18 million people. As the nucleus of political, financial, and cultural activities, the city grapples with formidable challenges in mobility and accessibility. Issues such as the dearth of quality public transport, inadequate non-motorized traffic infrastructure, heavy reliance on intermediary and informal transport, and chronic congestion have plagued its streets. What was once congestion restricted to main thoroughfares now infiltrates even the doorstep of its citizens. Startlingly, a recent World Bank report paints a dire picture—the average traffic speed has plummeted from 21 kilometers per hour to a mere 7 kmph over the last decade, projected to sink further to a staggering 4 kmph by 2035, slower than walking pace.

Although the Bangladesh Road Transport Authority has approved a total of 359 bus routes in Dhaka, only 150 are currently active, served by a fleet of over 6000 buses. The city's bus route network spans a mere 609 kilometers, a mere 7% of the total urban expanse. Despite numerous government-led development projects aimed at improving the public transport system, many have faltered due to mismanagement or inefficient transport policies. Recently, the government has embarked on visionary projects—the "Mass Rapid Transit (MRT Line 6)" and "Bus Rapid Transit (BRT Line 3)." However, these endeavors, while promising, are unable to cover the entirety of the city's transit network and face time-consuming implementations.

In response to the pressing need for an efficient and accessible public transport solution in the underserved areas of Dhaka, the government embarked on a transformative journey to introduce a swift, reliable, and cost-effective system. The circular and semicircular bus systems emerged as a globally recognized approach celebrated for their dependability, passenger-friendly features, and economic viability—all achieved without the need for extensive infrastructure development. This innovative concept revolves around buses circulating a central point while serving various peripheral locations where passengers board and disembark, presenting a pragmatic solution for improving urban mobility.

Implementing such a system in the intricate and unplanned urban fabric of Dhaka posed formidable challenges. However, driven by the goal of mitigating traffic congestion and enhancing overall mobility, the government committed to this ambitious undertaking. The initiative debuted with two routes in Gulshan, a pivotal commercial hub, in 2016, with the primary objective of providing congestion-free standard bus services. The success of this initial trial paved the way for the expansion of the system, leading to the introduction of two additional circular bus systems—the Mohammadpur-Azimpur Semicircular bus system and the Hairjheel Circular Bus System—since 2018.

Significantly, the implementation of these systems has not only reduced the prevalence of private and non-motorized vehicles on the city streets but has also instilled a sense of orderliness in other facets of urban services. This initiative represents a pivotal stride towards cultivating a healthier, more dynamic, and modern Dhaka, serving as a beacon of positive change within the public transport sector. As these circular and semicircular bus systems redefine urban transportation, they symbolize the first crucial step in the city's journey towards a more sustainable and efficient public transit network.

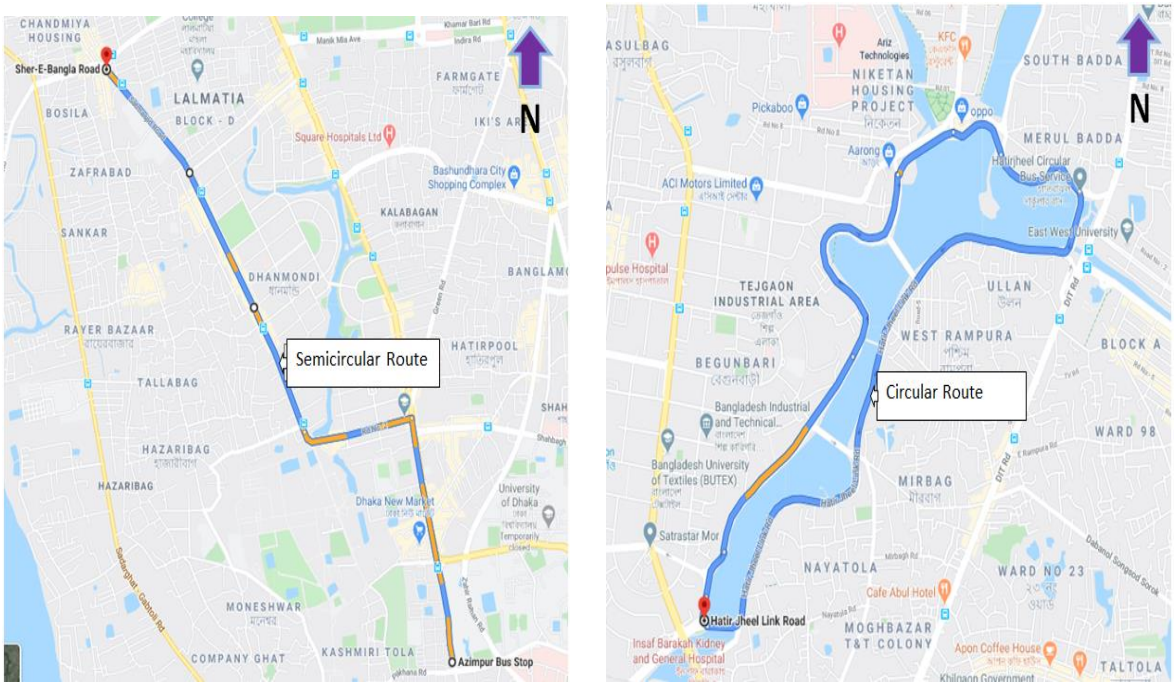

Figure 1: Bus Network Structure (a) Route-1 and (b) Route-2
(Source: Google Map)

4. DISCRETE CHOICE MODEL

A discrete choice model is a methodology to predict and analyze an individual's choice based on relative attractiveness (1).Relative attractiveness is function of satisfaction outcome and can be represented as

$$U_{ni} = V_{ni} + \epsilon_{ni} \quad (1)$$

$$V_{ni} = \alpha + b_n X_{ni} \quad (2)$$

Where,
U_{ni}= relative attractiveness of decision maker i towards given satisfactory level
V_{ni}= Deterministic Part
ϵ = random error due to uncertainty
α = constant term for satisfactory level
n=satisfactory level (1=excellent, 2=Satisfactory, 3=Moderate, 4=Poor)

Due to restrictive assumption, Deterministic part of equation 1 is precise enough to represent utility function. The probability that a given decision-maker n selects alternative i from given choice set n is expressed by following equation,

$$U(i|n) = \frac{e^{V_{ni}}}{\sum_{n=1}^{n=4} e^{V_{ni}}} \quad (3)$$

This model is developed as multinomial logit model and used for analyzing user satisfaction on various bus route in Dhaka City.

5. DATA COLLECTION & SAMPLING TECHNIQUES

Table 1: Service Quality Attributes

	BS-1					BS-2				
	Excellent	Satisfactory	Good	Poor	Satisfied User	Excellent	Satisfactory	Good	Poor	Satisfied User
Dependent Variable										
Bus Service Quality	110	230	310	70	47.22%	120	170	80	50	69.05%
Independent Variable										
Travel Time	10	290	310	110	41.67%	330	40	50	20	88.10%
Waiting Time	260	170	180	110	59.72%	330	40	50	5	88.10%
Bus Fare	20	20	10	690	2.78%	10	10	25	410	2.38%
Bus Availability	10	700	10	10	97.22%	10	300	20	120	71.43%
Speed	20	20	210	510	0.00%	10	40	120	260	9.52%

The investigation into bus service quality involved an extensive and meticulous data collection process, employing face-to-face surveys administered to commuters traversing specific routes within Dhaka city throughout the entire month of December 2019. The ambitious target was set at obtaining 1200 responses; however, the final sample comprised 1160 participants. The shortfall was attributed to the occasional reticence of a few passengers and unforeseen anomalies encountered during the survey administration.

Following the collection phase, a judicious post-filtering process was undertaken, resulting in the curation of 1140 responses for subsequent in-depth analysis. These selected responses formed the basis for the comprehensive assessment of service quality and the subsequent development of a robust choice model.

The evaluation methodology employed a well-established five-point Likert scale, encompassing ratings ranging from the pinnacle of service excellence, labelled as "Excellent" [1], to the lowest echelon denoted as "Very Poor" [5]. Notably, an intriguing observation surfaced during the analysis, with an inconspicuous representation of responses falling within the "Very Poor" category, accounting for less than 1% of the total dataset.

In light of this negligible representation, a judicious decision was made to amalgamate the "Poor" and "Very Poor" ratings into a singular category. This strategic consolidation not only streamlined the dataset but also facilitated the organization of the observed variables into four distinct and meaningful categories. This methodological adjustment was implemented to improve the accuracy and clarity of our subsequent analyses. The goal was to ensure a comprehensive understanding of the various facets within the bus service quality landscape when reviewing the data.

6. RESULT AND DISCUSSION

6.1 Travel Pattern Analysis

In terms of travel time, passengers predominantly rated BS-1 as satisfactory and BS-2 as excellent. This suggests that BS-1 experiences congestion likely due to additional turning requirements, making the one-way arrangement of BS-2 more satisfactory than the two-way BS-1. However, both BS-1 and BS-2 received poor ratings regarding speed due to repeated braking at turning points.

When it comes to waiting time, the majority of users rated BS-1 as excellent. It's interesting to note that all users of BS-2 rated it between good and excellent. The presence of some poor ratings for BS-1 indicates issues with time management.

Regarding bus fare, the majority of passengers rated it poorly, indicating a mismatch between fare and service quality. However, the accessibility of bus availability received satisfactory ratings for both service types, suggesting accessible counter locations for users.

6.2 Model Analysis

The multinomial logit model is constructed using responses from participants who were asked to assess various facets of bus service, including bus service quality, travel time, waiting time, bus fare, and operating speed, using ratings like excellent, satisfactory, good, and poor. This data is utilized to gauge passenger satisfaction levels for both BS-1 and BS-2. The overall evaluation of bus service quality for these two services is outlined below.

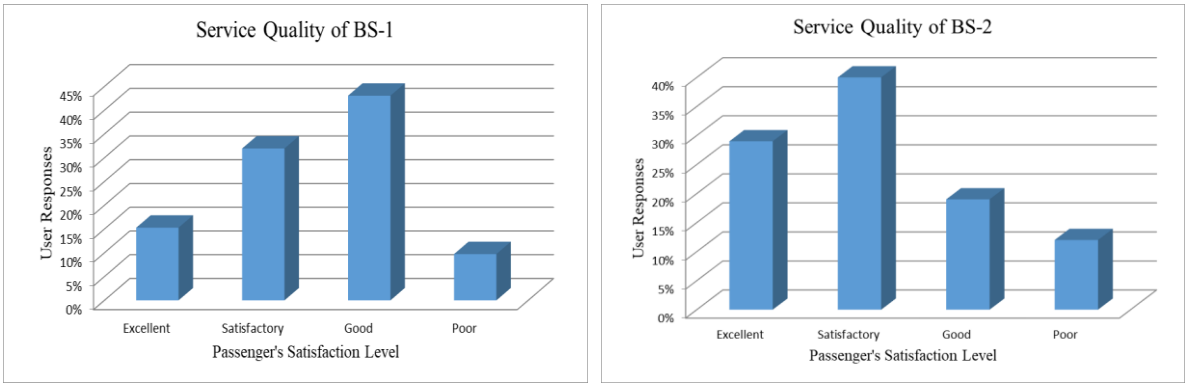

Figure 2: Passenger Response regarding overall service quality of (a) BS-1 and (b) BS-1

The analysis presented in Figure 2 illustrates that 40% of total respondents rated BS-2's overall service quality as satisfactory, with 12% rating it as poor. Conversely, for BS-1, there's a slight contrast: 43% of respondents rated its service quality as good, with 10% rating it as poor.

Various independent variables, encompassing non-random parameters, are used in the model to elucidate satisfaction levels. These variables include factors related to bus service such as travel time, waiting time, bus fare, bus availability, and operating speed. The dependent variable in this model is the overall bus service quality, with satisfactory being the reference category. The models were estimated using SPSS version 26 for statistical analysis.

The resulting multinomial logit model produced a McFadden pseudo Rho-square of 0.204 for the circular bus service and 0.109 for the semi-circular bus service. A significance value less than 0.05 indicates a poor fit of the model to the data, whereas values greater than 0.10 suggest the data align well with the model assumptions. In this case, the values exceed 0.10 for both services, indicating consistency with the model assumptions.

The parameter estimates table summarizes the effect of each predictor. If the significance level of the Wald statistic is below 0.05, it denotes a parameter different from zero. Constants significant at a 5% statistical level are employed in the model as random parameters, signifying significant variations influencing service quality, both between and within services.

Table 2: Coefficient of Service Quality

	BS-1(BS-2)		
Bus Service Quality	Excellent	Good	Poor
Travel Time	0.118	0.413	-0.684
	(-1.807)	(-0.168)	
Waiting Time	0.109	-0.455	0.318
	(-1.987)	(-1.344)	(-1.255)
Bus Fare	0.08	-1.093	-0.083
	(-0.235)	(-7.63)	
Bus Availability	0.299	0.596	0.19
	(-0.254)	(-0.075)	(-0.199)
Operating Speed	1.044	-0.179	0.37
	(-0.202)	(-1.832)	(-0.466)

The model outcome, displaying the nonrandom parameters in Table 2, illustrates how the coefficients of independent variables define the preference levels, such as excellent, good, or poor, in relation to the satisfactory category (the reference point).

For passengers using BS-1, the data indicates a tendency to rate the bus fare variable as "excellent," signaling a high level of user satisfaction with this aspect. Additionally, coefficients associated with "travel time" and "bus availability" suggest a trend where respondents are more inclined to rate these factors as "excellent" or "good," and less likely to rate them as "poor," likely due to the adequacy of the fleet size in meeting passenger demand.

A similar analysis for BS-2 reveals estimated coefficients that indicate satisfied passengers are more likely to rate "good" for both travel time and operating speed, owing to user-oriented operational management. However, respondents exhibit a higher preference for "excellent" regarding waiting time, while showing a tendency to rate the existing bus fare as "poor." This suggests that modifying the current bus fare could enhance the satisfaction level. The inadequate fleet size in the existing service, relative to demand, leads to a deviation in user satisfaction in the "bus availability" category, contributing to reduced user attraction.

6.3 Probabilistic Analysis of Waiting Time

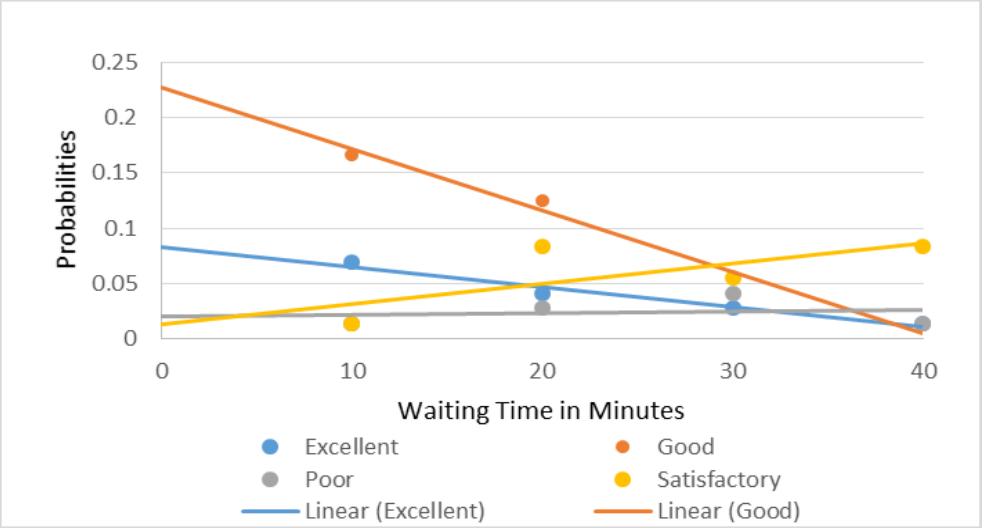

Figure 3: Probability Vs Waiting Time for BS-1

Waiting time emerged as the significantly influential factor, more so than operating speed, in the analysis of the studied bus services. For BS-1, waiting time was rated as ‘’Poor’’, and as waiting time increased, the probability for both “Good” and “Excellent” ratings decreased. Additionally, the linear “poor” category was associated with non-time-sensitive respondents, while the trend for “satisfactory” ratings showed a downward trajectory.

7. CONCLUSION

This study pioneers a novel comparative analysis of various public transport routes, introducing a framework to identify major service attributes and incorporating diverse passenger responses across professions, creating a more responsive model grounded in travel behavior. Employing a discrete choice model, it sheds light on the impact of waiting time as a significant factor within the model. While existing studies have overlooked distinct bus service parameters, this research aims to fill this gap by identifying key attributes in two bus service systems and proposing strategies to address user dissatisfaction. For BS-1, most aspects received ratings below 50%, signaling a need for improved management, while dissatisfaction with certain factors in BS-2 warrants further investigation. Revamping fare structures is crucial for both services to maintain and attract passengers, while implementing a bus priority system and ensuring adequate fleet sizes could enhance user experiences. Despite the study's limitation in not analyzing individual responses by specific passenger classes, it lays the groundwork for future studies, offering a framework for classified passenger satisfaction analysis and paving the way for advanced discrete choice model implementations.

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