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Research Article

A Comprehensive Assessment of University Transport Services at Pabna University of Science and Technology (PUST)

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Abstract

Efficient and accessible transportation services are crucial for facilitating smooth travel for students on university campuses. This study offers a thorough evaluation of the transportation services at Pabna University of Science and Technology (PUST), seeking to identify the primary factors affecting student satisfaction and preferences for travel modes. The study utilizes data gathered from 370 students using structured questionnaires, employing Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA) to assess the correlations between service quality features and student satisfaction. Significant data indicate that 54.9% of students prioritize cost-effectiveness as the foremost reason for utilizing the service, whereas 36.5% identify overcrowding and 31.6% emphasize inadequate seating space as substantial obstacles to usage. The Geographic Information System (GIS) study delineated service coverage, pinpointing accessibility deficiencies, especially in locales such as Bottola and Arifpur, where pupils encounter extended walking distances to bus stops. Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA) were utilized to examine latent variables, revealing substantial correlations between service quality attributes (e.g., safety, driver conduct) and student satisfaction. The model fit indices (RMSEA = 0.072, CFI = 0.904) affirmed strong statistical validity. Although there was reasonable satisfaction with travel speed (Mean = 3.48) and safety (Mean = 3.49), significant shortcomings were observed in seat availability (Mean = 2.20) and fleet size (Mean = 2.08). Only 39.2% of students employed GPS tracking, signifying restricted use of technology solutions. Student feedback highlighted the necessity for augmented bus frequency (44.3%) and expanded routes (18.6%) to improve service effectiveness. The study emphasizes the importance of data-driven planning and the improvement of transport services to achieve enhanced inclusivity, reliability, and user satisfaction. Its findings provide actionable insights for university authorities to optimize resource allocation and enhance the efficiency and accessibility of campus transport systems.

Keywords

University Transport Services, Pabna University of Science and Technology (PUST), Service Quality, Operational Efficiency, Fleet Capacity, Structural Equation Modelling (SEM), Student Satisfaction

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1. Introduction

Transportation services play a vital role in the daily lives of students, faculty and staff within university settings, ensuring seamless connectivity and enhancing the overall campus experience [1-3]. A well-designed transport service not only provides convenience and reliability but also contributes to sustainability efforts by reducing the reliance on private vehicles [4, 5]. Sustainable transport solutions, such as bus services, should be considered for university campuses [6-8], and crowded places like Dhaka and Pabna [9-12]. At most Bangladeshi universities, students heavily rely on public transportation. Low-quality campus bus services can lead to missed classes, wasted time, and discouraged use of shuttle buses. Additionally, tardiness, uncomfortable rides, safety concerns, and unsupportive staff contribute to bad perceptions of campus-provided transportation. For many educational institutions, including Pabna University of Science and Technology (PUST), transport services such as university buses are crucial in addressing commuting challenges and promoting a safe and efficient travel environment. Understanding the factors that influence student satisfaction with transport services is critical for improving these services and ensuring that they meet the needs of their users. This involves assessing service attributes such as accessibility, comfort, safety, travel time and cost, which can significantly impact students' preferences for certain modes of transport. The perceptions of service quality can influence students' overall satisfaction, which in turn affects their mode choice behavior. Therefore, analyzing these perceptions can provide valuable insights into the aspects of transportation services that need improvement.

Service quality is a primary determinant of satisfaction [13]. Recent studies have extensively examined student's satisfaction in relation to perceived university transport service quality, accessibility, and safety, which is crucial for comprehending the cause-and-effect relationship pertaining to sustainable transportation [14, 15]. Traffic externalities, such as noise and environmental pollution, time specific service, and not available seats may be intensified by the overutilization of the university transport service and the diminished use of public transport [16-18]. Consequently, the primary objective of university transport service is to enhance accessibility and safety for students [19].

Presently, researchers have used a range of methodologies, including Importance Performance Analysis (IPA) [20], structural equation modelling (SEM) [21-23], partial least squares-structural equation modelling (PLS-SEM) [24-26], discrete choice modelling (DCM) [27-29], multi-criteria decision-making (MCDM) frameworks [30], and Bayesian Networks (BN) [31-33]. Structural Equation Modelling (SEM) has been effectively utilized to analyze the relationships among variables [34]. This work employed PLS-SEM, with its selection grounded in many criteria, including the nature of the research, data type, sample size, and gap analysis.

This study aims to explore the factors influencing the satisfaction levels of students regarding university transport services using Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA). The objectives are to assess the relationships between service quality attributes and student satisfaction, identify the key factors affecting transport mode choices and offer recommendations for enhancing transport service quality at PUST.

2. Literature Review

The study of transport mode choice and service quality has been a focal point in transportation research, with various methodologies employed to understand the underlying factors that shape commuter behavior. Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA) are two robust analytical methods used to investigate complex relationships between observed variables and latent constructs in transport studies.

SEM and CFA have been widely used to model the relationships between service quality attributes and user satisfaction. SEM allows for the assessment of both direct and indirect effects of various factors on outcomes like satisfaction and behavioral intentions, making it ideal for studies that aim to understand the complexity of transport service evaluations [35]. CFA, on the other hand, is used to validate the measurement models by assessing the relationships between observed indicators and their underlying latent variables, ensuring that the constructs used in SEM are accurately measured [36]. Recent studies have utilized SEM to examine the influence of service attributes like travel time, comfort and safety on users' satisfaction and mode choice preferences. For example, a study at the University of Central Florida applied SEM to assess the impact of factors such as attitude toward carpooling and travel behavior on the decision to use shared transportation [37]. Similarly, research at German universities has shown that behavioral habits and planned behavior significantly influence transport mode choices [38].

Service quality attributes such as accessibility, safety and comfort play a crucial role in shaping students' satisfaction with university transport services. Several studies have highlighted that travel time is a significant barrier to the adoption of public transportation modes like buses [39]. Additionally, the convenience of access to bus stops, reliability of service and comfort during the journey are key determinants of student satisfaction [40]. The perceptions of service quality are often filtered through passengers' experiences, making it important to assess these perceptions when evaluating transit service performance [41]. Studies have shown that aspects like seat availability, cleanliness and the behavior of drivers can greatly influence students' overall satisfaction with transport services [42].

University campuses, as key trip-generating areas, present unique opportunities to study transport mode choice behavior due to their dense and diverse commuter populations. Research has shown that university students are more likely to adopt alternative transport modes like cycling or walking compared to the general population [43]. This makes universities an ideal setting for understanding the factors that drive the adoption of sustainable transportation modes. Studies have indicated that implementing transport demand management (TDM) policies, such as offering free transit passes or improving bus frequency, can significantly enhance public transport adoption among students [44]. These policies can help alleviate common barriers like long travel times and improve the attractiveness of public transportation for university commuters [45].

Service quality and user satisfaction have been widely investigated in Bangladesh's transport sector. Rahman [46] found that affordability, frequency, and comfort affected Chandra-Hemayetpur bus passenger satisfaction at Savar, Dhaka. In Manikganj, Paul et al. [47] compared Easy Bike services to traditional transport and found that commuter preferences are influenced by reliability and safety. Overcrowding and insufficient seating, reported by 36.5% and 31.6% of PUST students, respectively—remain satisfaction hurdles in urban transit. E-rickshaws in Rangpur [48] and walkability in Dhaka [8, 9] highlight infrastructural and route inefficiencies. Jamil et al. [49] stressed geometric road design in accident hotspots, echoing PUST's demand for safer bus routes. Akter et al. [50] observed that urban density directly influences travel behavior, suggesting that PUST's transport planning must consider peak-hour demand and student dispersal. Rahman and Kabir [51, 52] found that Uttara office commuters value comfort and accessibility over cost. In contrast, PUST students choose affordability (54.9%) over speed (13.5%). Sharif et al. [53] also linked transport inefficiencies to broader health and environmental impacts, advocating for integrated solutions like GPS tracking technology only 39.2% of PUST students utilize. Khan and Rahman [54] proposed a Road Management System (RMS) for neighborhoods, emphasizing data-driven planning. Rahman and Ritu [55] similarly stressed corridor-based multimodal integration, a strategy PUST could adopt to address unserved areas like *Bottola*. These studies advocate fleet growth, real-time tracking, and route optimization for PUST's transport system.

By applying SEM and CFA in this study, we aim to provide a comprehensive understanding of how various service quality attributes affect students' satisfaction and transport mode preferences at PUST. This research will not only contribute to the literature on transport service quality but also offer practical recommendations for enhancing the university transport system to better serve the needs of students.

3. Methodology

3.1. Study Area

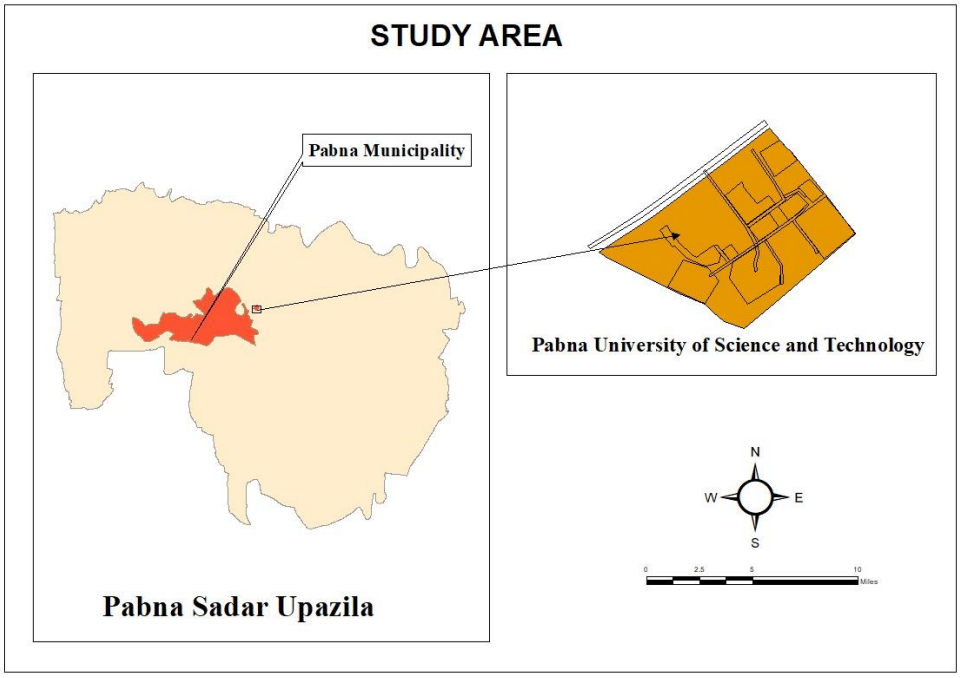

Figure 1. *Study Area Map.*

This study focuses on Pabna University of Science and Technology (PUST) situated in Pabna, Bangladesh. PUST serves as a central educational institution in the region, hosting a student population of approximately 5,000. The university's transportation services are vital for the daily commute of students, many of whom live off-campus. The transport system includes several double-decker and large buses that operate on designated routes, providing connectivity between the university campus and various parts of Pabna city. The choice of PUST as the study area is motivated by its diverse student population and the role of transportation in ensuring their access to academic facilities.

3.2. Survey Design & Data Collection

The study employed a structured survey questionnaire to gather data on students' perceptions and experiences with the university bus service. The questionnaire was designed to focus on critical aspects of the service, such as travel time, travel cost, safety, accessibility, comfort and overall satisfaction. Each item on the survey used a five-point Likert scale, ranging from "very dissatisfied" to "very satisfied," allowing for a nuanced understanding of students' satisfaction with various dimensions of the transport service.

3.3. Sampling and Respondents

To ensure a representative sample of the university's student population, a total of 370 students were surveyed, selected using Slovin’s formula. The respondents were chosen through random sampling to encompass a diverse range of demographics, including gender, age, living status and income levels. The survey was conducted over a one-month period, providing ample time for thorough data collection. This approach ensured that the survey responses accurately captured the experiences and perceptions of students regarding the university's transportation services.

3.4. Data Collection Techniques

In addition to the survey, interviews were conducted with key personnel, including bus drivers and transport service managers, to gain insights into the operational aspects of the service, such as bus schedules, routes and challenges faced during service delivery. Furthermore, GIS-based data collection was employed to analyze the spatial distribution of bus routes, focusing on service area coverage and the accessibility of bus stops. This geographic analysis provided a deeper understanding of how effectively the bus routes served different student populations, highlighting both served and unserved areas within the city.

3.5. Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA)

A structural equation model (SEM) was developed to examine the relationship between transport service satisfaction and transport mode choice. SEM is widely used in social sciences to analyze complex relationships among variables, serving as a comprehensive statistical tool that tests relationships between observed and latent variables from multiple independent and dependent variables. This model was developed using SPSS and AMOS 4.0 software.

The SEM consists of two main components:

Measurement Component: This links latent variables to observed variables using confirmatory factor analysis (CFA) methods, allowing the relationships between latent factors and their indicators to be assessed.

Latent and Manifest Variables

In SEM, two types of variables are used:

Manifest Variables: These are directly observed and measured through survey data.

Latent Variables: These are not directly measured but inferred through relationships among manifest variables. In this study, the latent variables include service quality dimensions like factors of bus and seats, service of bus and bus stoppage. Each latent variable is connected to its corresponding observed variables, such as smoothness of ride, driver behavior, cleanliness, safety and speed.

The survey identified various service attributes, which were categorized into three key latent variables: factors of bus and seats, service of bus and bus stoppage. SEM analyzed how these latent factors influence the overall satisfaction with the transport service.

3.6. Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA)

CFA was employed within the SEM framework to validate the measurement model, ensuring that the observed variables accurately represent the latent constructs identified in EFA. EFA was initially used to determine the underlying latent factors from the service attributes before specifying the CFA model.

3.7. Model Analysis and Path Diagrams

The SEM, constructed in AMOS, used path diagrams to visually represent relationships among manifest and latent variables, helping to identify causal relationships. The analysis included path coefficients and model fit indices such as RMSEA and CFI to evaluate the model's robustness. Additionally, GIS was integrated to illustrate the spatial aspects of bus service coverage, enhancing the understanding of the geographic distribution of service satisfaction and mode choice.

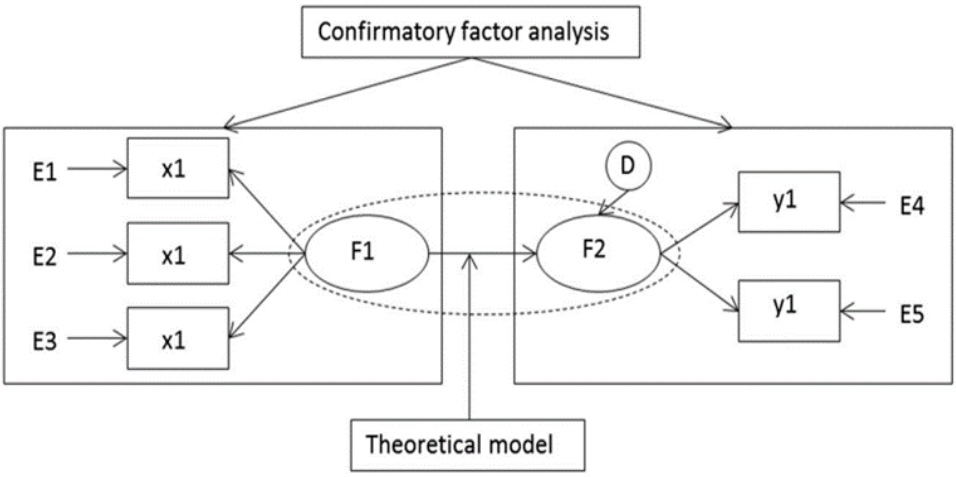

Figure 2. *Confirmatory Factor Analysis.*

Having established the theoretical relationships between service attributes and student satisfaction through the SEM framework, the following section presents the empirical results. These findings illustrate how well the model fits the data and the strength of the relationships between observed and latent variables. The empirical findings derived from the SEM model are detailed in the following section. These results not only validate hypothesized relationships but also quantify the influence of various service attributes on overall satisfaction with the university bus service. With the SEM framework and data collected, the following section presents the detailed results of the analysis, highlighting how each service attribute contributes to student satisfaction.

4. Result and Discussion

4.1. Preference of University Bus

The most frequently cited reason in this case is "economy," with 54.9% of respondents indicating that they favor bus service because it is a cost-effective mode of transportation. With 21.9% of respondents citing, it as their reason for preferring the bus service, "safety" is another significant factor.

Table 1. *Reason to prefer university transport service by the PUST student.*

Reason of preference	Frequency	Percent	Cumulative Percent
Faster	50	13.5	13.5
Economy	203	54.9	68.4
Safety	81	21.9	90.3
Reliability	28	7.6	97.8
No comments	8	2.2	100.0
Total	370	100.0	-

Fewer pupils favor the bus because it is "faster" (13.5%) or "reliable" (7.0%). In addition, a minor percentage (2.2%) of respondents did not indicate their preference for the bus service. These results indicate that the affordability and security of the university bus service are important factors for students, making it a desirable mode of transportation. Some pupils also place a lesser emphasis on the service's speed and dependability.

4.2. Reasons Behind the Non-utilization of University Bus Services

This data Table 2 reveals that there are multiple factors why students do not utilize the university bus service. The most frequently cited reason is "Overcrowding," cited by

36.5% of respondents as their reason for not taking the bus. With 31.6% of respondents citing, it as their reason for not taking the bus, "poor seat capacity" is the second-most-cited reason for not taking the bus. According to 19.2% of respondents, "schedule deviation" is another significant factor. 11.9% of respondents cite "distance of bus route" as the reason for their selection. In addition, a minor percentage (0.8%) did not provide an explanation for why they did not use the university bus.

Table 2. Causes of not using the university bus.

Causes of not using university bus	Frequency	Percent
Poor seat capacity	117	31.6
Distance of bus route	44	11.9
Overcrowding	135	36.5
Break of schedule	71	19.2
No comments	3	.8
Total	370	100.0

4.3. GPS User

Table 3 reveals that 39.2% of respondents indicated that they took advantage of a GPS tracking system. 60.8% of participants indicated that they do not utilize a GPS tracking system.

Table 3. Effectiveness of GPS tracking system based on opinion of GPS users.

Use of GPS tracking system	Effectiveness of GPS tracking system						Total
	Very dissatisfied	Dissatisfied	Moderate	Satisfied	very satisfied	No comments	
yes	3.0%	7.8%	14.1%	12.7%	1.6%	-	39.2%
no	-	0.3%	2.7%	0.3%	-	57.6%	60.8%
Total	3.0%	8.1%	16.8%	13.0%	1.6%	57.6%	100.0%

Among those who use GPS tracking systems, 3.0% are very dissatisfied. 7.8% are dissatisfied. 14.1% have a moderate level of satisfaction. 12.7% are satisfied. 1.6% are very satisfied. there are no comments provided. For respondents who do not use GPS tracking systems, there are minimal percentages reported in the "Very dissatisfied" (0.3%), "Dissatisfied" (2.7%) and "No comments" (57.6%) categories.

4.4. Condition of the Service Area

The majority of respondents, 44.1% of students, perceive the service area to be "moderate." In addition, 22.7% of students rate the service area as "good," while 17.8% rate it as "poor". A smaller percentage (13.5%), assesses the service area as "very poor" and very few people (1.9%), consider the service area to be "very good" (table 4).

The most common rating for the condition of the service area was "moderate," indicating that a significant portion of students believe that there is room for improvement. Addressing issues pertaining to the quality of the service area could conceivably increase the overall satisfaction of students who utilize these facilities.

Table 4. Condition of the service area.

Service area condition	Frequency	Percent
very poor	50	13.5
Poor	66	17.8
Moderate	163	44.1
Good	84	22.7
very good	7	1.9
Total	370	100.0

4.5. Need Improvements to Campus Transportation

A significant majority (90%) of those who provided suggestions emphasized the need for "more frequent buses," 44.3% while 18.6% suggested adding "more routes" to enhance the service (table 5). In addition, 17.8% expressed a desire for a "better bus," and 9.2% emphasized the need for "bus stops on campus".

Table 5. What need to improve of the university transport service.

Suggestion to improve varsity transport service	Kind of improvement they need					Total
	more route	more frequent buses	better bus	need bus stop in campus	No comments	
Yes	18.6%	44.3%	17.8%	9.2%	-	90.0%
No	0.3%	0.5%		0.3%	8.4%	9.5%
No comments	-	-	-	-	0.5%	0.5%
Total	18.9%	44.9%	17.8%	9.5%	8.9%	100.0%

Only a minuscule fraction (0.5%) of respondents did not provide any feedback. Intriguingly, a substantial portion (8.9%) of respondents did not offer any suggestions, possibly indicating that while some students have specific ideas for improvement, others are content with the current state of the transport service or have not considered potential enhancements. Overall, the findings highlight the strong demand for increased bus frequency and imply that addressing this aspect could considerably improve student satisfaction with the university's transportation service.

4.6. Walking Distance from Origin to Bus Route

The majority of students (40.5%) reside within a "5-10 minute" walking distance from the bus route. In addition, 30.5% of pupils reported living less than "5 minutes" away, making this the second most prevalent category. Approximately 20.5% of pupils have a "10-15 minute" walk to the bus stop, while 7.3% have a "greater than 15 minute" walk. A small percentage (1,1%) of respondents indicated "Others," indicating that their distances may differ for unique reasons.

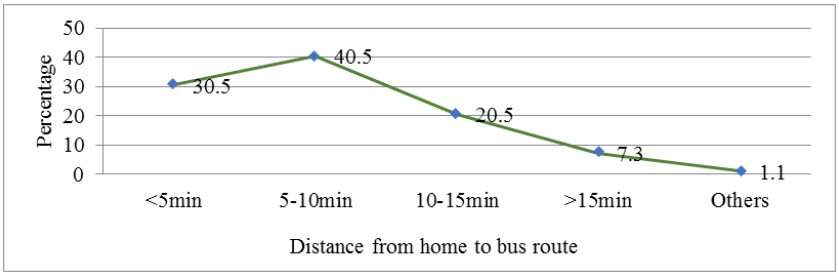

Figure 3. Distance from Origin to Bus Route.

These results suggest that a substantial proportion of students reside in close proximity to the bus route, which can contribute to the convenience and accessibility of the university bus service. However, there is still a sizeable proportion of students with lengthier walking distances to the bus stop. Improving transportation options or connectivity for these students should take this into account.

4.7. Service Area Coverage of the University Bus

There are two major bus routes - one from Campus to Terminal via Gachpara and Shohor and the other from Campus to Terminal via Shohor and Gachpara. The buffer map (figure 4) is created by GIS (Geographic Information System), which allows for precise location analysis and mapping of the routes. Most students access the buses by walking.

The average five-minute walking distance for students is ¼ mile (approximately 400 meters), which is based on the average human walking speed of 3 miles per hour [42]. The major finding is that we find out the origin point, destination point, and major areas served by bus routes. The bus route covers the main bus stoppage area where the students can easily get onto the bus. The served areas are Rajapur, Terminal, Laskarpur, Homeopathic college, Tal Bagan, Meril Bypass, Singa Bazar, Noorpur More, Gachpara, Dak Bangla, Moktob More, Edward College, Lotif Towe, Indira More, Binabani More, Court, Technical, Ananto, Mohiser Dipu, Mujahid club, Bangla clinik, Masum Bazar, Terminal, Male & Female hall where students can get the bus easily within 5 min walking distance. The unserved areas are Degree Bottola, Library Bazar and Arifpur and others, these areas are far from main bus route, students pick access mode to get the

transport service. We find out that most of the students get access to the bus by this route and the maximum area is served. This information can be valuable for transportation planning and decision-making, especially for improving accessibility for students and ensuring that the bus routes adequately serve the areas where students need transportation.

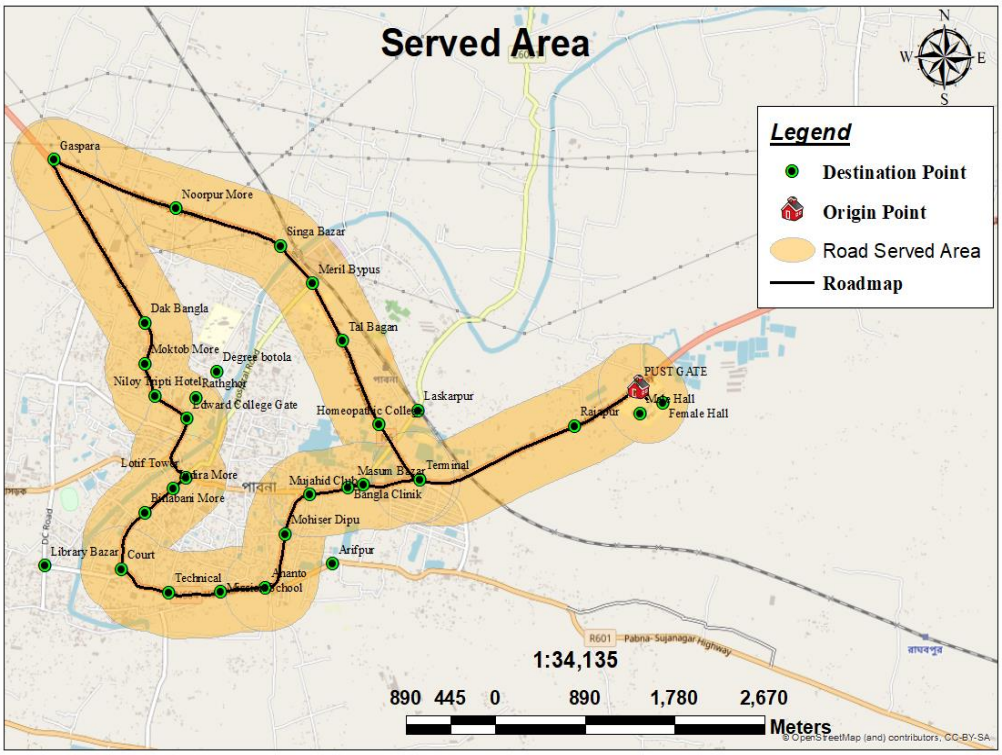

Figure 4. Service area coverage by the university bus.

4.8. Average USI of Difference Influencing Factors

The five- point Likert scale is considered an interval scale. The meaning is very significant. From 1 to 1.8 (5), it means 'very dissatisfied. From 1.81 to 2.60 (4), it means dissatisfied. from 2.61 to 3.40 (3) it means moderate; from 3.41 to 4.20 (2), it means satisfied; from 4.21 to 5 (1), it means very satisfied. The five-point Likert scale responses show (table 6) that students are moderately to satisfactorily satisfy with the university bus service.

Table 6. User satisfaction index.

USI influencing factors	N	Minimum	Maximum	Mean	Rank
Bus Schedule	370	1	5	2.82	3
Easy to access Bus stops	370	1	5	3.04	3
Route Layout	370	1	5	3.02	3
Waiting for Bus	370	1	5	2.85	3
Convenience Payment	370	1	5	3.19	3
Travel Speed	370	1	5	3.48	2
Smoothness Ride	370	1	5	3.45	2
Number of stoppages	370	1	5	3.00	3

USI influencing factors	N	Minimum	Maximum	Mean	Rank
Safety and Security	370	1	5	3.49	2
Cleanliness of vehicles	370	1	5	3.12	3
Seat availability	370	1	5	2.20	4
Bus driver Behaviour	370	1	5	3.35	3
Enough number of buses	370	1	5	2.08	4
Valid N (listwise)	370	-	-	-	-

"Travel Speed" and "Safety and Security" had higher mean values, showing that students are happier with these bus service elements. In contrast, "Seat availability" and "Enough number of buses" had lower mean scores, suggesting student unhappiness. These studies suggest ways to improve university bus riders' happiness, particularly seating availability and bus numbers. These findings suggest that students are usually satisfied with bus transportation services, including payment convenience, safety and security and driver conduct. There's less satisfaction with seat availability and bus numbers.

4.9. Structural Equation Model (SEM)

In the Structural Equation Model (SEM) Q1, Q2, Q3, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13 are observed variables; F1, F2 and F3 are latent factors; E1-E11 is errors of measurement (Figure 5).

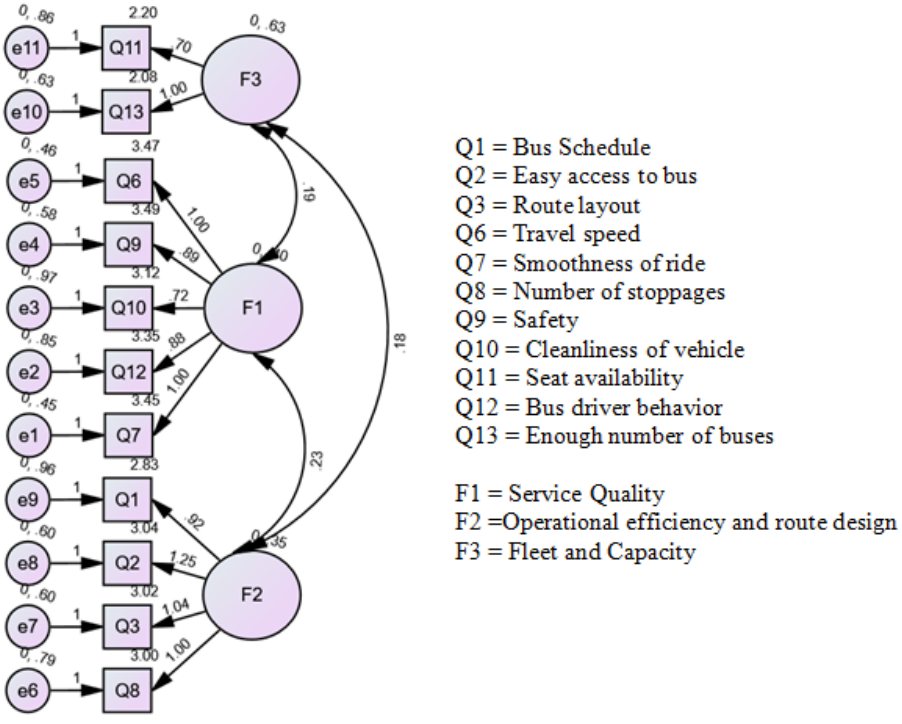

Figure 5. *Structural Equation Model.*

In the model, the error is also described as a residual that shows an unexplained part by selected variables. While the indicators were measured on Likert scales. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) are used to construct the structure of passengers' perceptions of bus service performance and extract major factors from 13 service attributes. To explain all service attributes of bus performance, EFA determined the number of latent factors and CFA verified the structural relationship among service attributes.

EFA is used to extract the three proper latent factors from a series of 11 service attributes. Using the VARIMAX rota-

tion technique, principal component analysis is performed to explore the latent factor dimensionalities of bus service attributes.

4.10. Result (Default Model) and Model Fit Information of SEM

Minimum was achieved
Chi-square = 118.979
Degrees of freedom = 41
Probability level =.000

SEM optimization converged, reducing the discrepancy between model predictions and observed data, indicates that the model fits the data. Chi-square = 118.979; The chi-square statistic measures how well your structural equation model matches data. A smaller chi-square value suggests a better fit. Chi-square testing uses 41 degrees of freedom to analyze independent data. The discrepancy between observed data points and calculated model parameters gives this study 41 degrees of freedom. probability level =.000; The chi-square statistics' probability level is near to zero, indicating extreme statistical significance between model predictions and observed data.

The value of RMSEA is 0.072
PCMIN/DF is 2.902
CFI is 0.904

An RMSEA value of 0.072 is relatively low and suggests that the model fits the data quite well. RMSEA values close to or below 0.08 are typically considered a good fit. CMIN/DF is a ratio that measures the goodness of fit per degree of freedom. A value of 2.902 indicates that, on average, each degree of freedom accounts for 2.902 units of discrepancy between the model and the observed data. Values below 3 are often considered acceptable. CFI assesses the relative improvement in fit of the model compared to an independence model (a null model). CFI values range from 0 to 1, with higher values indicating better fit. A CFI of 0.904 suggests a relatively good fit but not a perfect fit (ideal CFI would be 1).

Table 7. *Results of coefficient (SEM).*

Influence	Factors	Estimate	Standard Estimates	S.E.	C.R.	P
Smoothness Ride	Service Quality (F1)	1.000	.684	-	-	-
driver Behavior	Service Quality (F1)	.876	.513	.110	7.997	***
Cleanliness vehicles	Service Quality (F1)	.717	.417	.108	6.665	***
Safety and Security	Service Quality (F1)	.887	.591	.099	8.962	***
Travel Speed	Service Quality (F1)	1.003	.683	.102	9.864	***
Number stoppage	Operational efficiency and route design (F2)	1.000	.551	-	-	-
Route Layout	Operational efficiency and route design (F2)	1.037	.619	.135	7.699	***
easy access	Operational efficiency and route design (F2)	1.254	.690	.156	8.015	***
Bus Schedule	Operational efficiency and route design (F2)	.917	.482	.138	6.630	***
number buses	Fleet and Capacity (F3)	1.000	.705	-	-	-
Seat availability	Fleet and Capacity (F3)	.700	.512	.184	3.802	***

***P < 0.01

These regression weights show the strength and direction of relationships between latent factors (F1, F2, and F3) and their respective observed variables (table 7). Positive and significant relationships indicate that higher levels of latent factors are associated with higher values of corresponding observed variables. The observe variables have a significant influence on the Service Quality, Operational efficiency and route design, Fleet and Capacity.

The main finding of this structural equation model is that latent factors (F1, F2 and F3) and the corresponding observable variables have robust and statistically significant connections. All of the observed variables for Service Quality (F1), which mostly represent features of service quality like Smoothness Ride and Travel Speed, show substantial and positive relationships, with standardized estimates ranging from 0.513 to 0.684. With standardized estimates ranging from 0.551 to 0.690, all of which are extremely significant, F2, which stands for components like operational efficiency and route design, greatly effects Number stops, Route Layout, Easy access and Bus Schedule. F3, which is linked to capacity

and fleet-related factors, has a somewhat favorable effect on seat availability and a large positive impact on bus numbers. All of the correlations are statistically significant ($p < 0.001$) and the results show a well-structured model that highlights the influence of latent factors on the observed variables and offers insights into the key aspects influencing the system's performance.

5. Findings and Discussion

The study's findings underscore the primary strengths and notable limitations of the university transportation services at Pabna University of Science and Technology (PUST). The system proves beneficial for numerous students; however, there are essential aspects that necessitate prompt intervention to enhance its overall efficacy and accessibility. One of the major strengths of the university bus service is its economic appeal as indicated by 54.9% of respondents who prefer it for its affordability. This highlights the system's capacity to accommodate the financial limitations of students, rendering it a viable option for the majority. This dependence on cost-efficiency raises concerns regarding the trade-offs in other service dimensions, including capacity, reliability and safety. For instance, while 21.9% of respondents cited safety as a reason for preferring the service, this figure reflects room for improvement in ensuring a secure transportation experience for students. The issue of overcrowding cited by 36.5% of non-users and poor seat capacity (31.6%) exposes critical inadequacies in the current transport infrastructure. These factors not only inhibit usage but also indicate a system overwhelmed and insufficiently serving the growing student population. The system seems to lack the operational efficiency necessary to accommodate the varied needs of students, compounded by schedule disruptions (19.2%) and remote bus routes (11.9%). These constraints indicate an urgent need to augment the fleet size, refine routing and enhance scheduling. The adoption of the GPS tracking system also reveals a divide in user satisfaction. While 39.2% of students utilize GPS services, the majority (60.8%) do not, citing various reasons such as lack of awareness, usability issues, or inefficiencies in the system. Among users, the mixed satisfaction levels (e.g., 14.1% moderately satisfied and 12.7% satisfied) highlight a technology that holds potential but requires significant enhancements to deliver consistent value. This suggests that the successful modernization of services through technology relies on effective implementation and user involvement. Service quality perceptions are another mixed area. While 44.1% rated the service as moderate and 22.7% as good, a notable percentage rated it as poor (17.8%) or very poor (13.5%). This indicates that although the service fulfils basic expectations for most, it does not provide a consistently satisfactory experience universally. Factors such as seat availability and the number of buses received the lowest satisfaction ratings, highlighting systemic capacity challenges that impede student contentment. The findings also reveal accessibility disparities as many students (40.5%) reported walking 5-10 minutes to reach bus routes, while 7.3% reported walking over 15 minutes. This indicates that although the system effectively serves a substantial segment of the student population, it neglects others. Enhancing connectivity and adding more routes could alleviate these disparities, making the service more inclusive. Student suggestions provide valuable insights into areas of improvement. The demand for more frequent buses (44.3%) and additional routes (18.6%) indicates that addressing operational capacity is the top priority. Similarly calls for better buses (17.8%) and bus stops on campus (9.2%) highlight the need for infrastructure enhancements. However, the fact that 8.9% of respondents did not provide suggestions could reflect either satisfaction with the current system or disengagement with the feedback process, which requires further investigation. The structural equation model (SEM) analysis offers profound insights into the latent factors affecting satisfaction. Attributes like travel speed, safety and security and driver behavior were strongly associated with service quality, while seat availability and number of buses emerged as critical gaps. This emphasizes the need for a balanced approach that addresses both qualitative aspects (e.g., safety, cleanliness) and quantitative aspects (e.g., capacity, fleet size).

The structural equation model (SEM) analysis further highlights key aspects influencing the perception of university bus services. Factors such as service quality, operational efficiency and route design and fleet and capacity were identified as significant determinants of overall satisfaction. Attributes like travel speed, safety and security and driver behavior were positively associated with service quality, while factors such as seat availability and number of buses emerged as areas requiring immediate attention.

Overall, the findings suggest that while the university transport services meet the basic needs of many students, improvements in capacity, schedule reliability, accessibility and safety measures are crucial. Addressing these areas could significantly enhance student satisfaction and the overall efficiency of transport services at PUST.

6. Conclusion

This study highlights the importance of university transport services at PUST, with affordability and safety being key reasons for utilization. However, challenges such as overcrowding, inadequate seat capacity, schedule disruptions and limited accessibility significantly impact service effectiveness. While technological solutions like GPS tracking show potential, their adoption and satisfaction remain limited. Students underscore the necessity for increased bus frequency, expanded routes and enhanced infrastructure. Addressing these gaps alongside enhancing capacity, reliability and safety, can make the system more inclusive and efficient. A focused

data-driven approach will ensure greater student satisfaction and accessibility.

Abbreviations

CFA	Confirmatory Factor Analysis
DCM	Discrete Choice Modelling
EFA	Exploratory Factor Analysis
GIS	Geographic Information System
IPA	Importance Performance Analysis
PLS-SEM	Partial Least Squares-structural Equation Modelling
PUST	Pabna University of Science and Technology
RMS	Road Management System
SEM	Structural Equation Modelling
TDM	Transport Demand Management

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Conflicts of Interest

The authors declare no conflicts of interest.

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