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Bus Shuttle Service Operations and Students' Satisfaction at the Federal University of Technology, Minna

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This study evaluates the quality of campus bus shuttle service operations and student satisfaction at the Federal University of Technology, Minna (FUTMinna), Nigeria, using the SERVQUAL framework. A cross-sectional survey of 400 randomly selected students was conducted while passengers were on board shuttle services operating between Gidan-kwano and Bosso campuses. Data analysis employed descriptive statistics using SPSS. Results revealed that 60.8% of respondents were male, with 68.5% aged 18-25 years. The primary motivation for service patronage was low transport fares (69.8%). All five SERVQUAL dimensions (reliability, assurance, tangibility, empathy, and responsiveness) recorded negative gap scores ranging from -0.50 to -0.71, indicating poor perceived service quality. The operational model was found to be moderately efficient, while the funding model demonstrated efficiency. However, the irregular scheduling pattern proved ineffective. The study recommends adopting public-private partnership models, implementing regular scheduling systems, and enhancing service quality across all dimensions to improve student satisfaction and campus mobility.
Keywords: Campus transportation, Service quality, SERVQUAL, Student satisfaction, University shuttle service

Introduction

Campus transportation systems serve as critical infrastructure supporting the academic and social activities of university communities globally. In developing countries, where urban transportation challenges are particularly acute, universities increasingly assume responsibility for providing reliable and affordable mobility solutions for their students and staff. Providing quality campus shuttle services has become essential for ensuring accessibility, reducing transportation costs, and enhancing the overall student experience in university environmental (Ogbiti *et al*., 2025; Buran, 2025).

The Federal University of Technology, Minna (FUT Minna), operates across two campuses: Gidan-Kwano and Bosso located along the Bida – Minna Road, approximately 15 kilometres apart. As such, the availability of shuttle buses necessitates efficient inter-campus transportation systems to facilitate student movement. Like many Nigerian universities, FUT Minna has established shuttle services to address transportation challenges and provide cost-effective alternatives to private transportation. However, the effectiveness and quality of these services require systematic evaluation to ensure they meet student expectations and contribute positively to campus life (Adekya *et al*., 2926). Transportation service quality significantly influences user satisfaction and continued patronage in both public and institutional contexts. Research demonstrates that quality transportation services enhance accessibility, reduce travel stress, and improve overall user experience (Luke & Heyns, 2020). In university contexts specifically, poor shuttle service quality can adversely affect academic performance, social integration, and overall student well-being, making systematic quality assessment crucial for institutional effectiveness (Clay & Valentine, 2021).

Despite the establishment of shuttle services at FUTMinna, concerns persist regarding service reliability, scheduling effectiveness, and overall quality. Students frequently experience challenges related to irregular schedules, vehicle breakdowns, and inadequate service provision. These operational deficiencies may compromise student satisfaction and undermine the intended benefits of campus transportation systems. However, systematic evaluation of service quality and student perceptions remains limited, creating a knowledge gap regarding the effectiveness of current shuttle operations and areas requiring improvement. The absence of empirical assessment using standardised frameworks limits evidence-based decision-making for service enhancement (Ogbiti *et al*., 2020;

Therefore, the aim of this study is to assess the operational effectiveness of bus shuttle services and students' satisfaction levels at the Federal University of Technology Minna, using the SERVQUAL framework. The specific objectives are to: examine the operational characteristics and models employed in the FUTMinna shuttle service system; evaluate students' perceptions and expectations of shuttle service quality across the SERVQUAL dimensions; establish the relationship between service operations and student satisfaction; and identify areas for improvement in shuttle service delivery and operations.

Literature Review

University transportation service models

Contemporary university transportation systems employ various operational models to address campus mobility needs. Research by different scholars identifies four primary frameworks for university transit operations: operational management approaches, funding mechanisms, service scope definitions, and environmental responsiveness strategies (Mahmoudi *et al*., 2024). The operational model fundamentally determines how universities manage shuttle services, ranging from fully internal operations to partnerships with external providers or hybrid arrangements combining institutional management with contracted operations.

Private operation models, where universities maintain complete control over service provision, according to Cascetta (2009), offer greater flexibility in route planning and service customisation but require substantial capital investment and operational expertise. These models, as observed by Siemiatycki (2013) enable universities to align services directly with institutional priorities and student needs while maintaining quality control. Conversely, authors like Siemiatycki (2013) are of the opinion that public-private partnerships can leverage external expertise while maintaining institutional oversight, potentially improving service efficiency and reducing operational costs. Therefore, the choice of operational model significantly influences service quality outcomes, cost-effectiveness, and long-term sustainability.

Regional studies in African contexts reveal that university transportation systems often operate under resource constraints, necessitating innovative approaches to service delivery. Nigerian universities particularly face challenges balancing affordability with service quality, often resulting in compromised operational effectiveness (Gbadamosi & Akanmu, 2021). Understanding these contextual factors is crucial for developing appropriate service delivery models.

SERVQUAL framework in transportation assessment

The SERVQUAL framework developed by Abukhalifeh and Som (2015) provides a comprehensive approach for measuring service quality across five dimensions: reliability, assurance, tangibility, empathy, and responsiveness. In transportation contexts, reliability encompasses schedule adherence, service consistency, and operational dependability. Assurance relates to passenger safety, staff competence, and confidence-building behaviours. Tangibility includes physical facilities, equipment condition, and personnel appearance. Empathy involves individualised attention, convenience, and customer-focused service delivery. Responsiveness encompasses staff willingness to assist, prompt service provision, and effective communication (Bellizzi *et al*., 2020).

Recent applications of SERVQUAL methodology in public transportation systems have demonstrated significant relationships between service quality dimensions and user satisfaction. Bolaños *et al*. (2022) found that reliability and responsiveness dimensions most strongly influence passenger satisfaction in urban bus systems. Similarly, Kruadsungnoen and Upayokin (2025) identify tangibility and assurance as critical factors in university transportation contexts, where students prioritise safety and comfort alongside operational reliability.

The gap analysis approach inherent in SERVQUAL methodology effectively identifies specific service quality deficiencies by comparing user expectations with perceived performance. Negative gap scores indicate performance below expectations, providing clear indicators for improvement priorities. This approach has proven particularly valuable in institutional settings where service enhancement requires targeted interventions (Charbatzadeh *et al*., 2016).

Student satisfaction and campus transportation

Student satisfaction with campus transportation services influences multiple aspects of university experience, including academic performance, social engagement, and institutional loyalty. Research demonstrates that reliable, affordable, and comfortable transportation services enhance student mobility, reduce stress, and improve overall campus experience (Clay & Valentine, 2021). Quality transportation services facilitate access to academic resources, social opportunities, and support services, contributing to student success and retention.

Conversely, poor transportation quality creates barriers to academic participation, limits social interactions, and contributes to student dissatisfaction with university life. Studies indicate that transportation challenges can particularly affect students from lower socioeconomic backgrounds who rely heavily on institutional services (Johnson *et al*., 2025; Clay & Valentine, 2021). This emphasises the equity implications of transportation service quality in university contexts.

Research in developing country contexts reveals that students prioritise affordability, safety, and reliability in campus transportation services, often accepting quality compromises when cost-effective alternatives are limited (Adekya *et al*., 2019). However, institutions that successfully balance affordability with service quality demonstrate higher student satisfaction and improved institutional reputation (Fatorachian & Kazemi, 2025).

Operational efficiency and service quality

The relationship between operational efficiency and service quality in transportation systems involves complex trade-offs between cost management and performance standards. Efficient operations require optimised resource utilisation, including fleet

management, route planning, and scheduling systems (Bolaños *et al*., 2022). However, excessive focus on cost reduction can compromise service quality and user satisfaction.

Successful university transportation systems achieve operational efficiency through strategic planning, technology integration, and performance monitoring. Digital technologies, including GPS tracking, mobile applications, and automated scheduling systems, can enhance operational efficiency while improving user experience (Nguyen & Mogaji, 2022). These technologies enable real-time service information, route optimisation, and performance monitoring. Fleet management practices significantly influence both operational efficiency and service quality. Preventive maintenance programs, vehicle replacement planning, and capacity optimisation contribute to service reliability while controlling operational costs (Rojas et al., 2020). Universities that implement systematic fleet management demonstrate improved service performance and reduced operational disruptions.

Funding models and sustainability

Research identifies three primary funding approaches: opt-in systems in which students pay directly for services, opt-out models that provide universal access with voluntary participation, and mandatory fee structures that ensure comprehensive coverage (Greben *et al*., 2024). Each approach presents distinct advantages and challenges regarding revenue generation, service accessibility, and student acceptance. Successful campus transportation systems often combine multiple funding sources, including student fees, institutional subsidies, and external partnerships. This diversified approach reduces financial risk while enabling investments in service quality (Fatorachian & Kazemi, 2025). Cost-effectiveness analysis reveals that strategic investments in service quality can improve user satisfaction and patronage levels, potentially enhancing financial sustainability.

Sustainability considerations extend beyond financial aspects to include environmental and social dimensions. Universities increasingly recognise transportation services as opportunities to demonstrate environmental commitment through fleet electrification, route optimisation, and modal integration (Etukudoh *et al*., 2024). These initiatives can enhance institutional reputation while potentially reducing operational costs through energy efficiency and maintenance savings.

Study Area

The Federal University of Technology, Minna (FUTMinna), located in Niger State, Nigeria is a specialised technological institution established in 1983. The university serves over 20,000 students across multiple engineering, science, and technology disciplines, distributed across two primary campus locations necessitating comprehensive transportation services. The main Gidan-Kwano campus houses the university's administrative headquarters, most academic faculties, and primary student residential facilities. This campus serves as the institutional centre, accommodating the majority of academic activities and administrative functions. The Bosso campus, located approximately 15 kilometres from the main campus, functions as an extension facility accommodating additional academic programs, research facilities, and supplementary residential areas.

The geographical separation between campuses creates significant transportation demands for students, faculty, and staff who must travel between locations for various academic, administrative, and social purposes. Daily movement patterns include students attending classes on both campuses, accessing library and laboratory facilities, participating in social activities, and utilizing administrative services. These movement requirements occur throughout the day, from early morning to evening, necessitating reliable frequent transportation services.

FUTMinna transportation infrastructure includes university-owned shuttle buses operating alongside private operators who provide supplementary services. The institutional fleet consists of buses specifically designated for inter-campus transportation, operating on routes connecting major campus facilities and residential areas. The service is designed to provide affordable, reliable transportation options while reducing student dependence on expensive private alternatives. The operational environment presents various challenges including traffic congestion during peak hours, vehicle maintenance requirements, fuel cost fluctuations, and varying demand patterns throughout academic sessions. Weather conditions during rainy seasons can affect service reliability, while security considerations require coordination with campus safety protocols. Understanding these contextual factors is essential for evaluating service performance and identifying improvement opportunities.

Research Methodology

This study employed a quantitative research design using cross-sectional survey methodology to comprehensively assess shuttle service quality and student satisfaction. The research framework was based on the SERVQUAL model, which enables systematic evaluation of service quality dimensions and gap analysis between student expectations and perceptions. The methodology was designed to capture both operational characteristics and user perspectives through multiple data collection approaches.

The study population comprised all FUT Minna students who utilise campus shuttle services for inter-campus transportation. A sample size of 400 respondents was considered for the survey. A random

sampling methodology was employed to select participants, with systematic procedures implemented during data collection. Inclusion criteria required respondents to be currently enrolled FUTMinna students with experience using campus shuttle services. Respondents were approached while boarding or travelling on shuttle services between Gidan-Kwano and Bosso campuses during operational hours (7:00 AM to 6:00 PM). This approach ensured data collection from active service users, enhancing the relevance and accuracy of responses while capturing diverse usage patterns throughout operational periods.

The questionnaire instrument comprised three main sections designed to capture comprehensive information about service quality perceptions and user characteristics. Data analysis employed multiple analytical approaches to comprehensively address the research objectives. Descriptive statistics, including frequencies, percentages, means, and standard deviations, characterised respondent demographics and service quality perceptions. These analyses provided a foundational understanding of sample characteristics and initial service quality assessments. Gap analysis calculations determined differences between perception and expectation scores for each SERVQUAL dimension and individual items using the formula: SQ = P - E, where SQ represents the service quality gap score, P indicates the perception score, and E indicates expectation score. Negative gap scores indicate performance below expectations, while positive scores suggest performance exceeding expectations.

Results and Discussion

Demographic characteristics and service usage patterns

The demographic analysis of 400 survey respondents revealed distinctive patterns in shuttle service utilization across different student populations The gender distribution showed 60.8% male participation and 39.2% female participation, indicating greater male engagement with shuttle services. This distribution potentially reflects broader patterns of campus mobility and transportation preferences among university students. Age distribution concentrated primarily in the 18-25 years category, representing 68.5% of respondents, which aligns with typical undergraduate student demographics. In addition, segments included 26-30 years (20.3%), 31-35 years (6.5%) and below 18 years (4.3%), with minimal representation in older categories (0.5%). This age distribution suggests that shuttle services primarily serve traditional-age university students with mature students represented in smaller proportions.

Service utilisation frequency patterns revealed varied levels of engagement with shuttle transportation systems. The largest user segment utilised services three times per week (49.5%), suggesting regular but not daily use of shuttle services. Additional frequency patterns included daily usage (16.0%), once weekly usage (16.8%), twice weekly (11.8%), and irregular or uncertain usage (6.0%). These patterns reflect diverse academic schedules, residential arrangements, and individual transportation preferences among students. Experience duration with shuttle services indicated substantial user retention and familiarity with variations in service quality. The largest segment comprised students with three or more academic sessions of experience (44.3%), followed by those with one to two academic sessions (41.5%), and newcomers with less than one session (14.3%). This distribution suggests that most respondents possess sufficient experience to provide informed assessments of service quality trends and operational effectiveness.

Table 1: Demographic Characteristics and Service Usage Patterns

Characteristic	Category	Frequency	Percentage
Gender	Male	243	60.8
	Female	157	39.2
Age Group	Below 18	17	4.3
	18-25 years	274	68.5
	26-30 years	81	20.3
	31-35 years	26	6.5
	Above 36 years	2	0.5
Usage Frequency	Once weekly	67	16.8
	Twice weekly	47	11.8
	Three times weekly	198	49.5
	Daily	64	16.0
	Irregular/Uncertain	24	6.0
Patronage Duration	Less than 1 session	57	14.3
	1-2 academic sessions	166	41.5
	3+ academic sessions	177	44.3

Characteristic	Category	Frequency	Percentage
Future Patronage	Will continue	268	67.0
	Undecided	120	30.0
	Will discontinue	12	3.0

Service quality assessment using SERVQUAL framework

A Comprehensive analysis of service quality using the SERVQUAL methodology revealed significant performance deficiencies across all measured dimensions. The assessment employed gap analysis, comparing student expectations with perceived service performance, providing detailed insights into specific areas requiring improvement.

From Table 2, the analysis shows that the reliability dimension recorded the second-largest performance gap (-0.65), indicating significant student dissatisfaction with service dependability, schedule adherence, and operational consistency. Reliability encompasses critical service attributes including punctuality, schedule regularity, vehicle dependability, and operational predictability. The substantial gap suggests that students experience frequent service disruptions, irregular scheduling, and inconsistent service delivery that weaken their ability to depend on shuttle services for regular transportation needs.

On the Empathy dimension, the result showed the largest performance gap (-0.71), despite moderate perception scores (3.42), indicating relatively high expectations (4.13). This dimension encompasses individualised attention, convenient operating hours, customer interest consideration, and accessibility provisions. The magnitude of this gap highlights critical deficiencies in customer relationship management, service personalisation, and responsiveness to diverse student needs. Students perceive limited institutional attention to their individual transportation requirements and insufficient consideration of diverse usage patterns. The Tangibility dimension in it achieved the highest perception scores (3.61) but still recorded significant negative gaps (-0.57) against elevated expectations (4.18). While students acknowledged reasonable physical facilities, vehicle maintenance standards, and staff presentation, performance remained substantially below desired standards. This suggests that infrastructure improvements and enhanced physical service attributes could significantly improve overall service perceptions.

Assurance and responsiveness dimensions both recorded identical gap scores of -0.50 indicating moderate but significant performance deficiencies in safety provisions, staff competence, and service responsiveness. These dimensions encompass passenger safety, staff knowledge and courtesy, confidence-building behaviours, willingness to help, and effective communication systems.

Table 2: SERVQUAL Dimensions Analysis - Expectations, Perceptions, and Gap Scores

Dimension	Expectation Mean	Perception Mean	Gap Score	Standard Deviation (Expectation)	Standard Deviation (Perception)
Reliability	4.05	3.40	-0.65	0.90	0.81
Assurance	4.05	3.55	-0.50	0.87	0.70
Tangibility	4.18	3.61	-0.57	0.88	0.50
Empathy	4.13	3.42	-0.71	0.88	0.63
Responsiveness	4.07	3.57	-0.50	0.89	0.45

Detailed attribute analysis

Individual SERVQUAL attribute analysis revealed specific performance challenges across service dimensions, providing targeted insights for improvement initiatives. These detailed assessments identified particular operational areas requiring immediate attention and resource allocation.

Within the reliability dimension, the most significant performance gaps occurred in driver politeness (-0.77) and passenger queuing management (-0.75). These findings indicate behavioural and operational management deficiencies that affect user experience quality. Schedule regularity (-0.62) and punctuality (-0.54) gaps reflect systematic scheduling challenges affecting service dependability and user planning capabilities.

Assurance dimension analysis revealed concentrated gaps in driver occupational knowledge (-0.87) and passenger safety in staff transactions (-0.69). These results suggest significant needs for driver training programs, competency development initiatives, and safety protocol improvements. The substantial gap in perceived driver competence indicates that students question the professional qualifications and service capabilities of shuttle operators. Responsiveness dimension demonstrated the largest individual attribute gap in customer communication (-0.94), followed by timely service provision (-0.78). These

findings indicate critical deficiencies in the communication system deficiencies and service delivery challenges that affect students' perceptions of institutional responsiveness to their transportation needs.

Table 3: Detailed SERVQUAL Attributes Analysis

Dimension	Attribute	Expectation Mean	Perception Mean	Gap Score	p-value
Reliability	Punctual arrival	4.00	3.46	-0.54	0.00
	No queuing delays	4.01	3.26	-0.75	0.01
	Vehicle reliability	4.10	3.55	-0.55	0.00
	Regular schedules	4.12	3.50	-0.62	0.00
	Driver politeness	4.00	3.23	-0.77	0.00
Assurance	Transaction safety	4.02	3.33	-0.69	0.00
	Driver competence	4.03	3.16	-0.87	0.00
	Passenger confidence	4.09	3.81	-0.28	0.00
	Queue organization	4.07	3.90	-0.17	0.02
Tangibility	Driver appearance	4.17	3.37	-0.80	0.00
	Waiting facilities	4.20	3.54	-0.66	0.01
	Seat comfort	4.10	3.73	-0.37	0.01
	Vehicle maintenance	4.21	3.82	-0.39	0.00
	Interior space	4.20	3.71	-0.49	0.02
Empathy	Customer interest	4.13	3.46	-0.67	0.01
	Convenient hours	4.18	3.26	-0.92	0.02
	Campus accessibility	4.09	3.55	-0.54	0.01
Responsiveness	Individual attention	4.00	3.58	-0.42	0.01
	Service information	4.01	3.99	-0.02	0.00
	Timely service	4.11	3.33	-0.78	0.00
	Clear communication	4.10	3.16	-0.94	0.00
	Staff helpfulness	4.12	3.81	-0.31	0.02

Reasons for service patronage and satisfaction levels

Analysis of patronage motivations revealed the dominant influence of economic factors on student transportation decisions, while also identifying opportunities to service quality improvements to enhance competitive positioning.

Cost considerations dominated student patronage decisions, with 69.8% of respondents (n=279) identifying low transport fares as the primary motivation for using shuttle services. This finding demonstrates the critical importance of affordability in student transportation choices and suggests that price competitiveness offers significant advantages over alternative transportation options. The dominance of cost-based decision-making indicates that students prioritise economic accessibility over service quality when transportation budget constraints are significant.

Secondary patronage factors included easy accessibility (10.5%, n=42), lack of alternatives (9.3%, n=37), travel suitability (6.8%, n=27), and appreciation of service quality (3.8%, n=15). The limited recognition of service quality as a patronage factor highlights opportunities for improvement initiatives that could enhance competitive positioning while maintaining cost advantages.

Despite documented service quality deficiencies, 67% of respondents (n=268) indicated willingness to continue using shuttle services, while 30% (n=120) remained undecided and only 3% (n=12) expressed definite discontinuation intentions. This retention pattern suggests that students value the service despite quality concerns, primarily due to affordability and limited alternatives. However, the substantial proportion of undecided respondents indicates potential for improved satisfaction through targeted service enhancements.

Table 4: Reasons for Shuttle Service Patronage

Reason	Frequency	Percentage
Low transport cost	279	69.8
Easy accessibility	42	10.5
No other alternatives	37	9.3
Suitable for travel	27	6.8
Good service quality	15	3.8
Total	**400**	**100.0**

Operational Model Assessment

Comprehensive assessment of FUTMinna operational approach revealed mixed effectiveness across different system components, providing insights for strategic improvements and policy modifications. The university employs a privately operated program model in which the institution maintains complete ownership and control over shuttle services. This model provides institutional autonomy in service design and delivery but places full operational responsibility on university resources and management capabilities. At the time of data collection, FUTMinna operated 10 buses of which only 7 were functional representing 70% fleet availability. This operational capacity limitation contributes to service reliability challenges and affects overall perception of service quality. The institution maintained differential pricing between university-operated buses (₦100) and private operator services (₦120), demonstrating cost advantages for institutional services while allowing market-based alternatives. This pricing strategy supports affordability objectives while offering service options for users with varying quality and convenience preferences.

The scheduling system employed irregular, demand-driven operations rather than fixed-interval scheduling. While this approach potentially responds to immediate demand fluctuations, it creates unpredictability for users and contributes to negative reliability perceptions. The absence of systematic scheduling undermines service dependability and limits user planning capabilities, contributing to satisfaction challenges. Fleet management practices revealed maintenance challenges affecting service reliability, with 30% of vehicles out of service during the study period. This maintenance backlog indicates needs for enhanced fleet management systems, preventive maintenance programs, and vehicle replacement planning to ensure consistent service availability.

Planning Implications

The study has present significant implications for transportation planning and service delivery enhancement at FUTMinna, while also providing insights applicable to similar university contexts in developing countries. The systematic identification of service quality gaps provides a foundation for evidence-based planning interventions designed to improve both operational effectiveness and user satisfaction.

The assessment reveals that at FUTMinna, the current privately operated model requires strategic modifications to address identified performance gaps while maintaining cost advantages. Transitioning toward a hybrid public-private partnership arrangement could leverage external expertise in fleet management, maintenance, and operations while preserving institutional control over service design and pricing policies. This approach could potentially increase operational efficiency, improve service reliability, and enhance professional service delivery standards.

Implementation of systematic performance management frameworks would enable continuous monitoring of service quality dimensions and user satisfaction trends. These systems should incorporate regular SERVQUAL assessments, operational performance indicators, and user feedback mechanisms to support data-driven decision-making and service improvement initiatives. Key performance indicators should include punctuality rates, vehicle availability, passenger load factors, and satisfaction scores across SERVQUAL dimensions.

Fleet management optimisation is critical a planning priority, given the identified maintenance challenges and capacity limitations. Developing comprehensive fleet replacement programs, preventive maintenance schedules, and capacity expansion plans could significantly improve service reliability while reducing operational disruptions. Strategic partnerships with vehicle maintenance providers or fleet management companies could enhance technical capabilities while controlling costs.

Service quality enhancement strategies

The substantial negative gap scores across all SERVQUAL dimensions indicate significant service quality deficiencies that require coordinated improvement initiatives. Priority should focus on reliability improvements, given the critical importance of dependable service for student transportation planning and the magnitude of performance gaps in this dimension.

Reliability enhancement strategies should emphasise systematic scheduling implementation, replacing the current demand-driven approach with fixed-interval

services that provide predictable departure times. Clock-face scheduling with consistent service intervals would improve user planning capabilities while demonstrating institutional commitment to dependable service delivery. Supplementary demand-responsive services could accommodate peak-period requirements and special events while maintaining core scheduled services.

Infrastructure improvements addressing tangibility dimension gaps should prioritise passenger waiting facilities, vehicle interior comfort, and driver professional presentation standards. Enhanced waiting areas with weather protection, seating, and service information displays would improve user comfort while demonstrating a commitment to service quality. Vehicle interior improvements, including comfortable seating configurations and adequate passenger space, could significantly enhance user experience perceptions.

Driver training and professional development programs should address identified competency and behavioural gaps, particularly in customer service, route knowledge, and professional conduct. Standardized training curricula should cover safety protocols, customer relations, vehicle operations, and emergency procedures. Regular performance evaluation and continuing education requirements would ensure consistent service delivery standards.

Technology integration and communication enhancement

The identified communication deficiencies require comprehensive technology integration to improve user access to information and service coordination. Mobile application development providing real-time vehicle locations, schedule information, and service updates would address responsiveness gaps while enhancing user convenience. These systems should include features for service feedback, route planning assistance, and emergency communication capabilities.

Digital communication platforms should complement traditional information channels to ensure broad accessibility across diverse student populations. SMS notification systems, social media updates, and website integration could provide redundant communication pathways reducing information gaps and service uncertainty. Integration with university information systems would enable seamless communication about service changes, special events, and operational updates.

GPS tracking and fleet management systems would support both operational efficiency and user information provision. For real-time vehicle monitoring enables optimized dispatching, route adjustments, and maintenance scheduling while providing data for service information systems. These technological investments could significantly improve both operational performance and user satisfaction outcomes.

Financial sustainability and funding diversification

While the current opt-in funding model demonstrates effectiveness in terms of affordability and student acceptance, the identified service quality gaps suggest needs for enhanced financial resources to support improvement initiatives. Exploring supplementary funding sources could enable service quality investments without significantly increasing student costs or compromising accessibility.

Potential funding diversification strategies include institutional subsidies recognizing transportation as essential student support infrastructure, external partnerships with local government or private sector entities, and revenue generation through auxiliary services such as advertising or premium service options. Cost-benefit analysis of service improvement investments versus funding requirements would ensure sustainable enhancement strategies.

Graduated service option development could accommodate diverse student preferences while maintaining affordable basic services. Premium services offering enhanced comfort, reliability, or convenience could generate additional revenue supporting overall system **improvements** while preserving accessible core services for cost-sensitive users.

Conclusion

This study of FUTMinna shuttle services reveals significant service quality deficiencies across all SERVQUAL dimensions, with negative gap scores ranging from -0.50 to -0.71. Despite these shortcomings, students continue to use the service primarily because of low fares and limited alternatives, indicating that affordability alone cannot substitute for quality improvements.

The study identifies eight critical recommendations for enhancement. First, implementing a hybrid operational model through public-private partnerships would leverage external expertise while maintaining institutional control over pricing and service design. Second, systematic scheduling modernization replacing irregular demand-driven operations with fixed-interval clock-face scheduling would improve reliability and predictability. Third, fleet management optimization is urgent, given the current 70% vehicle availability rate requires comprehensive maintenance programs and capacity expansion. Fourth, technology integration through mobile applications, GPS tracking, and real-time passenger information systems would address communication gaps. Fifth, infrastructure development focusing on weather-protected waiting areas and comfortable vehicle interiors would enhance tangibility perceptions. Sixth, professional development programs for drivers covering customer service, safety protocols, and professional conduct would improve assurance and responsiveness dimensions. Seventh, continuous performance monitoring systems incorporating

regular SERVQUAL assessments would enable data-driven improvements. Eighth, a phased implementation framework should prioritise cost-effective interventions such as scheduling modifications and training programs before capital-intensive technology and infrastructure investments. Successful implementation requires stakeholder engagement, clear timelines, and accountability mechanisms. While students tolerate quality compromises when affordable alternatives are scarce, systematic improvements could significantly enhance satisfaction, strengthen institutional reputation, and potentially increase service utilisation. The study emphasizes that cost advantages should complement rather than replace quality service delivery in university transportation systems.

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