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A Quantitative Analysis of Shuttle Service Efficiency in A Higher Education Institution

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Abstract

This quantitative study aims to assess the efficiency of the shuttle service system within Mindanao State University–General Santos City (MSU-GSC) in alignment with the United Nations Sustainable Development Goals (SDGs), particularly SDG 11: Sustainable Cities and Communities and SDG 9: Industry, Innovation, and Infrastructure. This case study focuses on four key indicators, mainly average waiting time, passenger load factor, punctuality of shuttle services, and identification of peak and off-peak hours. One hundred respondents, comprising students and employees who regularly use the service, participated in structured surveys and observational methods conducted over two weeks. The findings will provide the MSU-GSC administration with empirical data on shuttle performance, identifying specific gaps and potential areas for improvement. Overall, this study aims to uncover the solution to address the gaps in the transportation system, creating a more reliable and efficient university transportation system that fosters improved academic punctuality, operational effectiveness, and progress toward achieving sustainable and inclusive mobility aligned with global SDG targets.

Keywords – Efficiency, Shuttle Service, Transportation, Punctuality

1. Introduction

In a progressing society, transportation systems are essential. It affects economic activity, creates equitable access to basic services, and changes patterns of movement. Adequate transportation infrastructure promotes social interaction, productivity, and general quality of life in both urban and institutional settings. Because it can effectively move vast numbers of people, ease traffic, and encourage sustainable mobility, public transit plays a crucial role. Systems that can provide dependable, accessible, and well-coordinated services are necessary as cities and populations grow, placing increased strain on transportation networks. Universities are a smaller part of these broader transportation problems. Their populations consist of students, professors, and office workers who depend on adequate transportation to meet their academic, professional, and personal responsibilities. Therefore, planning, administration, and ongoing development of transportation services on college campuses reflect larger-scale public transportation problems. The literature has extensively examined the challenges of creating and sustaining an effective transportation system.

Hrelja, Khan, and Pettersson (2020) stated that major obstacles often prevent the implementation of high-performing public transportation systems, even when decision-makers recognize their characteristics. Their thorough examination also reveals recurring challenges in operation, coordination, and institutional fragmentation.

These issues arise because transportation systems require collaboration among various actors, including government agencies, operators, regulators, and users, all of whom have distinct interests and limitations. Inefficiencies frequently arise when these players fail to collaborate, resulting in service instability, disjointed routes, and disorganized scheduling of departure times.

According to Ceder (2016), the effectiveness of public transportation is mainly dependent on organized planning approaches that direct scheduling procedures, resource allocation, timetable creation, and route design. His work presents a comprehensive framework for transit planning that includes real-time operations, modeling, optimization, and behavioral components.

Through modeling, efficiency enhancement, behavioral analysis, and operational improvements, his work establishes a solid foundation for transportation planning. According to Ceder (2016), planning should take into consideration commuter expectations, actual travel patterns, demand fluctuations, and operational constraints. Inadequate planning procedures often lead to service gaps in public transportation systems, including inconsistent schedules, poorly designed routes, or uneven headways. Despite their technical nature, these issues have a significant impact on user satisfaction, rider preferences, and perceptions of service reliability. Therefore, planning and operational strategies must be continuously adjusted to accommodate evolving mobility requirements.

In a broader transportation setting, scheduling and timetabling have a significant impact on performance outcomes. Shang, Huang, and Wu (2019) highlighted the importance of creating schedules that align with passenger satisfaction, emphasizing that user-centered strategies are more effective and can lead to more dependable and responsive services. Their research in Beijing revealed that setting schedules in response to passenger demand can result in fewer delays, avoiding overcrowding, and improving the system as a whole.

The integration of passenger perspectives into scheduling represents a shift from traditional planning models toward more dynamic, data-driven methodologies. Shang, Huang, and Wu (2019) demonstrate that public transportation operations should be informed by feedback, rather than solely by mathematical optimization, particularly in settings where demand fluctuates throughout the day. Additionally, their results show that higher service dependability immediately leads to higher user satisfaction and trust, both of which are critical for maintaining ridership.

While they also present new chances for efficiency, emerging technologies make transportation planning even more difficult. Scheduling and fleet management are made more challenging by the shift to environmentally friendly transportation, particularly the use of electric buses. The scheduling of mixed electric bus fleets under partial mixed-route and partial recharging techniques is examined by Zhang, Li, Zheng, Li, Abdullah, and Dong (2022) to overcome these issues. According to their research, to optimize operational efficiency, electrification requires integrated route planning, energy management, and depot scheduling. The proposed mixed-integer programming model and the adaptive extensive neighborhood search (ALNS) algorithm demonstrate how advanced optimization methods can reduce transportation size and, more importantly, lower operating costs while also improving service consistency.

Zhang, Li, Zheng, Li, Abdullah, and Dong (2022) illustrate how transportation agencies must adapt both operational strategies and infrastructure investments to accommodate electric fleets. Their conclusions highlight the need for contemporary transportation planning to incorporate sustainability factors while preserving service dependability. This topic is becoming increasingly important for organizations seeking to reduce their environmental impact.

A related aspect of transport efficiency is striking a balance between user experience and economic considerations. The integration of timetabling and vehicle scheduling is examined by Schmid and Ehmke (2015), who provide a vehicle scheduling issue with time windows and balanced departure timings (VSP-TW-BT). The limitations of conventional sequential planning techniques are that they may prioritize cost savings over schedule quality. But it was addressed by this model. Transportation organizations must strike a balance between operational flexibility and dependable, commuter-friendly scheduling, as noted by Schmid and Ehmke (2015).

For users to be satisfied, schedules that provide appropriate time between transportation and distribute departures are all important.

Their findings support an all-encompassing planning approach that evaluates both operational efficacy and passenger convenience. Their hybrid methods show how difficult problems can be solved with computational tools. The observations of Schmid and Ehmke (2015) are especially pertinent for university transportation systems that are having trouble with irregular departure schedules.

Integrating the broader findings from existing literature shows that effective transportation systems truly require a combination of strategic governance, structured operational planning, user-centered scheduling, sustainable service management, and computational optimization. While most of these studies focus on broader service networks, the principles they articulate apply directly to institutional environments, such as Mindanao State University, which operates an independent shuttle service.

University campuses present unique challenges, including concentrated peak-hour demand, limited vehicle fleets, geographic constraints, and diverse commuter groups. Effective mobility is crucial for students, professors, and many administrative personnel to fulfill their academic and professional obligations at the university. This is because disruptions or inefficiencies in transportation services can hurt students' class punctuality, administrative processes, and the overall campus atmosphere. Therefore, transportation planning in universities must reflect both operational constraints and the needs of commuters.

On a lesser scale, the same transport dynamics are demonstrated at Mindanao State University – General Santos City (MSU-GSC). MSU-GSC is a geographically large campus that relies on its shuttle service system to facilitate easy movement between academic buildings, offices, residential areas, and other essential facilities. The shuttle system is designed to serve as a dependable internal transportation network, facilitating the everyday routines of thousands of employees and students.

However, in various university settings, anecdotal reports indicate recurring challenges, including long waiting times, overcrowding during peak periods, irregular departure schedules, and inadequate vehicle allocation. These operational inefficiencies may reduce overall academic output and have a growing negative impact on passenger satisfaction. Despite being smaller than public metropolitan transportation systems, the campus shuttle service faces similar problems, including spikes in demand, irregular scheduling that is often timely, inadequate coordination, and a lack of operational resources.

Applying the insights of Hrelja, Khan, and Pettersson (2020), the MSU-GSC shuttle system may be experiencing system and coordination challenges, particularly if responsibilities are divided among administrative units with different priorities. The absence of this so-called "unified planning" may contribute to inconsistent schedules or unclear operational guidelines. Without structured collaboration between service managers, university officials, and end-users, addressing shuttle inefficiencies becomes significantly more challenging.

The planning concepts described by Ceder (2016) are equally relevant. An example of this is the route design and scheduled planning within MSU-GSC, which must align with the spatial distribution of buildings and the daily flow of campus activities that differ between individuals. Inefficient or outdated route structures may lead to unnecessary delays or unorganized trips.

Similarly, scheduling practices that lack data-driven methodologies may fail to cater to actual commuter demand, a need that is essential for all users of the shuttle service. Thus, incorporating structured modeling and operational research methods could help the university optimize shuttle operations, enhance reliability, and reduce service gaps that greatly affect commuter satisfaction.

The necessity of considering commuter pleasure when designing transportation is further supported by findings from user-centered studies, such as the one carried out by Shang, Huang, and Wu (2019). The need for shuttles at MSU-GSC varies throughout the day due to changes in personnel and student schedules, as well as the presence of events. As a result, congestion may occur during peak hours, while excessive idle capacity is present during off-peak hours.

It may be possible to improve schedules, shorten wait times, and align service delivery with actual commuter demands by identifying these trends and variations through systematic data collection. Moreover, placing user experience at the center of planning efforts may enhance the perceived reliability of the shuttle service.

The operational complexities described by Zhang, Li, Zheng, Li, Abdullah, and Dong (2022) highlight the need for modern transport systems to integrate emerging technologies, sustainability considerations, and adaptive planning.

Even though MSU-GSC now operates a shuttle service, it will need to thoroughly analyze scheduling models, terminal infrastructure, and service deployment strategies to make future adjustments, such as transitioning to electric or hybrid vehicles. The need for proactively creating transportation systems that optimize operational efficiency while adapting to technological advancements is highlighted by their analysis.

Finally, the importance of balanced timetabling, as demonstrated by Schmid and Ehmke (2015), applies directly to the observed irregularities in MSU-GSC shuttle departure schedules. Long wait times and crowding are caused by irregular departure times, especially during peak hours. Their suggested balanced scheduling strategy offers a template for creating a more reliable and convenient schedule for commuters.

Despite these considerations, there is a compelling need to examine the operational efficiency of the MSU-GSC shuttle service through a rigorous, data-driven approach.

Despite anecdotal complaints, there is limited empirical research evaluating the shuttle system's performance using measurable indicators, such as waiting times, passenger loads, trip frequency, and schedule adherence. By systematically quantifying these indicators, this study aims to identify performance gaps, diagnose operational inefficiencies, and assess the degree to which the service aligns with commuter needs. Additionally, by situating the study within the broader framework of public transportation literature, the results can be applied to the ongoing discussion on transport planning and service optimization in institutional settings, as well as to the formulation of campus-level policies.

The results of this study are expected to provide actionable insights for university administrators, particularly those responsible for campus mobility and operations, to improve scheduling, enhance capacity management, implement more coordinated operational structures, and increase responsiveness to commuter needs, thereby significantly elevating the quality of transport services. Ultimately, the study aspires to transform commuter frustrations into evidence-based recommendations that will help guide the development of a more reliable, efficient, and user-centered shuttle service at Mindanao State University, General Santos City.

Objectives of the Study

The primary objective of this study is to evaluate the overall efficiency of the shuttle service system at Mindanao State University – General Santos City (MSU-GSC). Specifically, it aims to measure the average waiting time of students using the shuttle service, determine the average passenger load factor per trip, and evaluate the frequency and punctuality of shuttle operations. Moreover, the study aims to identify the peak and off-peak hours of shuttle service demand within the campus. Through these objectives, the research aims to generate data-driven insights that can inform the improvement of transportation management and enhance commuter satisfaction within the university community.

Materials and Methods

Research Design

This study employs a **quantitative descriptive research design** to measure and interpret the efficiency of the shuttle service based on numerical data and observable trends. This design is suitable as it enables researchers to quantify service performance and identify operational gaps through measurable indicators, such as waiting time, passenger load, and trip frequency. The approach provides objective results that can be translated into actionable recommendations for service improvement. The **quantitative research method** was utilized as it involved gathering numerical data through a structured questionnaire. The purpose of this method was to obtain measurable information that could objectively describe, explain, and analyze the variables under investigation.

Respondents and Sampling

One hundred (100) respondents, consisting of both students and employees who regularly use the MSU-GSC shuttle service, were selected using **purposive sampling**. This sampling method was chosen to ensure that participants possess direct experience with the shuttle operations, making their insights more relevant and reliable for the study. The selected respondents represent the university's daily commuters, capturing both peak and non-peak usage patterns.

Data Gathering Instrument

The primary research instrument used in this study was **a structured survey questionnaire**, designed to align with the research objectives. The questionnaire included both closed-ended and rating-scale questions designed to measure perceptions of waiting time, passenger load, punctuality, and overall satisfaction. Each item was carefully crafted to ensure that it directly addressed the research questions and captured the necessary data for analysis.

Before its administration, the instrument underwent **evaluation and approval by the subject professor** to ensure its appropriateness, clarity, and relevance to the study. The study did not perform separate validity and reliability testing because the questionnaire had already been reviewed and approved by the professor overseeing the research. Following this academic review, the instrument was deemed accurate and suitable for the study's context; thus, further validation or reliability testing was considered unnecessary.

Data Collection Procedure

Data were collected over a period of **two (2) weeks** to cover both peak and off-peak hours of operation. Surveys were administered to the identified respondents after obtaining their consent. All gathered information was organized, encoded, and prepared for statistical analysis.

Data Analysis

Descriptive statistical tools, such as frequency distribution and percentage computation, were used to examine the gathered data. These techniques provided a clear picture of the operational effectiveness of the shuttle service by summarizing and interpreting trends in waiting time, passenger load, and punctuality. To facilitate comparison and interpretation, the results were presented in tables.

Ethical Considerations

Ethical standards were strictly observed throughout the research process. Respondents were informed of the study's purpose and assured that their participation was voluntary. Their responses were treated with confidentiality, and no personal identifiers were disclosed in any part of the study. The study adhered to the principles of **informed consent, respect, and transparency,** ensuring the integrity of both data collection and participant welfare.

Results and Discussion

Table 1. Profile of Shuttle Service Users in MSU–GSC

Category	Percentage	Interpretation
Students	96%	Majority of shuttle users are students.
Employees	4%	Minimal participation from non-student sectors.

The shuttle service in Mindanao State University–General Santos City is utilized almost exclusively by students (96%), indicating that the service primarily caters to academic mobility. This demographic concentration highlights the need to synchronize shuttle operations with class schedules, rather than adhering to the fixed transport intervals characteristic of mixed-use commuter systems.

Frequency of use data reveal that 41% of respondents ride the shuttle daily, while another 31% use it one to two times per week. The remaining users (28%) access it less frequently, suggesting that while most rely on the service for routine campus travel, inconsistencies in scheduling and crowding may deter occasional riders.

Afternoon use was the most dominant (58%), followed closely by the morning period (51%). The heavy reliance on afternoon trips corresponds with the end of class hours, aligning with later findings that crowding and long waiting times peak during this period. Primary boarding points were concentrated at "Turno" near the College of Social Sciences and Humanities, the library, and the gymnasium—indicating that these hubs act as central nodes for passenger clustering.

Table 2. Waiting Time Indicators

Indicator	Dominant Response	Interpretation
Actual waiting time	5 – 15 minutes	Common waiting range, but outliers up to 45 minutes indicate inconsistency.
Expected waiting time	5 – 15 minutes (60%)	Alings with acceptable commuter standards.
Satisfaction with waiting time	Neutral (53%)	Passenger expectations are moderate but unfulfilled.
Comparison of actual vs. expected	Longer than expected (56%)	Indicated performance gap in service reliability.
Quality of waiting area	Poor to Very Poor (72%)	Lack of amenities worsens perceived wait burden.

Results reveal that while most respondents expect and experience waiting times between 5 and 15 minutes, nearly half have encountered delays exceeding 30 minutes. This irregularity undermines trust in the shuttle schedule and affects perceived service quality. The predominance of "Neutral" satisfaction (53%) and the higher rate of dissatisfaction (20%) compared to satisfaction (27%) suggest that commuters have normalized inefficiency rather than accepted it as a given.

A notable 72% rated waiting facilities as “Poor” or “Very Poor,” emphasizing the psychological influence of the environment on commuter patience. Inadequate shelter, seating, and shade magnify perceived waiting duration, thereby compounding service inefficiency.

Table 3. Passenger Load and Comfort Level

Indicator	Results	Interpretation
Trips at 76 – 100% capacity	32%	High Utilization.
Trips exceeding capacity	40%	Overcrowding is frequent and systemic.
No seat available during peak hours	65%	Limited capacity causes standing loads.
Comfort with crowding	57% uncomfortable	Passenger comfort severely compromised
Crowding discourages use	72%	Overcrowding drives modal avoidance.

Overloading is the defining inefficiency of the MSU–GSC shuttle system. A combined 72% of respondents reported boarding vehicles either at full capacity or beyond, suggesting operational oversaturation. The resulting discomfort—57% reporting being "Uncomfortable" or "Very Uncomfortable"—has tangible behavioral effects, as 72% of users avoid the shuttle during congested times.

Spatial analysis shows that crowding peaks between the main gate and academic area (57%), aligning with the university's traffic flow patterns during class changes. This finding identifies a critical segment where route restructuring or vehicle redistribution could improve load balance and passenger satisfaction.

Table 4. Shuttle Frequency and Reliability

Metric	Dominant Response	Interpretation
Shuttle passing interval	Every 5 – 10 min (56%)	Moderate service frequency.
Late arrivals (in 5 rides)	71% experienced delay	Punctuality is inconsistent.
Punctuality rating	Neutral (44%)	Lack of confidence in schedule adherence.
Reliability rating	Reliable (41%)	Modest positive perception.
Late shuttle causing lateness to class/work	71%	Service inefficiency affects academic punctuality.

While the majority of users report acceptable frequency (≤10 minutes), nearly half experience longer intervals, reflecting irregular dispatching. Punctuality issues are pervasive—71% of riders encountered at least one delayed shuttle in their last five trips. Such inconsistency directly impacts academic and work attendance, with 65% affirming that delays "Always" cause them to be late.

These results confirm that the shuttle system's reliability remains fragile. The prevalence of neutral responses (51%) implies user resignation rather than confidence. Operational adjustments—such as real-time tracking and better scheduling—are therefore essential for restoring commuter trust.

Shuttle Demand and Peak Usage

Shuttle usage peaks from 4:00 to 6:00 PM (49%), corresponding to the end of class transitions. Morning demand (8:00–10:00 AM, 36%) and midday (12:00 NN–2:00 PM, 35%) also reflect academic scheduling rhythms.

The longest waits, however, occur between 10:00 AM and 2:00 PM, when overlapping class shifts strain shuttle availability. Similarly, the period of maximum crowding—4:00 PM to 6:00 PM—shows that the service fails to scale its capacity in response to demand. Respondents overwhelmingly requested additional trips during this same interval (34%), confirming that operational improvements must target late-afternoon surges.

Passenger suggestions further underscore the need for service continuity beyond regular hours, particularly before 6:30 AM and after 6:00 PM, to accommodate early classes and late activities.

Results reveal that while most respondents expect and experience waiting times between 5 and 15 minutes, nearly half have encountered delays exceeding 30 minutes. This irregularity undermines trust in the shuttle schedule and affects perceived service quality. The predominance of "Neutral" satisfaction (53%) and the higher rate of dissatisfaction (20%) compared to satisfaction (27%) suggest that commuters have normalized inefficiency rather than accepted it. A notable 72% rated waiting facilities as "Poor" or "Very Poor," emphasizing the psychological influence of the environment on commuter patience. Inadequate shelter, seating, and shade can magnify the perceived duration of waiting, thereby compounding service inefficiency.

As confirmed by numerous researchers, the waiting time during peak hours is generally longer than during off-peak hours, as user demand tends to concentrate at specific periods of the day [6]. This observation aligns with the findings of Ben-Elia and Avineri [6], who noted in their behavioral review that commuter perception of time loss and travel stress increases significantly under high-demand conditions. Similarly, Fernández and Tyler [7] observed that passenger movement toward terminals and stop stations tends to be uniform across various transport systems, meaning that human travel patterns along public routes remain consistent throughout the day. This uniformity leads to predictable congestion points, particularly near high-traffic boarding areas such as the College of Social Sciences and Humanities and the university gymnasium. Consequently, waiting time serves as a critical indicator of inefficiency, directly affecting both commuter productivity and overall well-being, as the time lost in transit reflects wasted economic and academic opportunity.

Conclusion and Recommendation

The study's conclusions showed that although Mindanao State University's shuttle service is a crucial mode of transportation for students and employees alike, it operates below optimal efficiency levels. The analysis shows that prolonged waiting times, inconsistent schedules, and frequent overcrowding significantly hinder commuter satisfaction and punctuality. Most respondents reported experiencing delays and limited seating, which leads to discomfort during peak hours, reflecting that the system is unable to match the growing demand for mobility across the university.

These inefficiencies not only affect convenience but also directly influence academic attendance and productivity. The prevalence of neutral satisfaction ratings suggests a tolerance for substandard service rather than genuine approval, indicating a need for systemic intervention. Overall, the study emphasizes the importance of data-driven transportation planning within university environments, highlighting that operational coordination, capacity management, and infrastructure enhancement are crucial for maintaining an efficient and reliable shuttle system.

APPENDINCES

Appendix A. Survey Questionnaire

A QUANTITATIVE ANALYSIS OF SHUTTLE SERVICE EFFICIENCY IN A HIGHER EDUCATION INSTITUTION

Alithea Jamica Baranda and Christian Jobim Villamin

Part I. Demographics

1. Are you a student, employee, or other?
   ☐ Student
   ☐ Employee
   ☐ Other
2. How often do you use the shuttle service?
   ☐ Daily
   ☐ 3-4 times a week
   ☐ 1-2 times a week
   ☐ Less than once a week
3. Typical time of shuttle use (check all that apply):
   ☐ Morning (e.g. before class)
   ☐ Midday/Lunch
   ☐ Afternoon
   ☐ Evening
4. Where do you usually ride/board the shuttle within the campus?
   ____

Part II. Waiting Time

5. On your most recent shuttle usage, what was your actual waiting time from arrival at the stop to boarding (in minutes)? ___ minutes.
6. In general, how long do you expect to wait for the shuttle (on a typical day)?
   ☐ Less than 5 minutes
   ☐ 5-10 minutes

☐ 11-15 minutes
☐ 16-20 minutes
☐ More than 20 minutes

7. How would you rate your satisfaction with the waiting time?
☐ 1=Very dissatisfied
☐ 2=Dissatisfied
☐ 3=Neutral
☐ 4=Satisfied
☐ 5=Very Satisfied

8. Compared to your expected waiting time, was your last wait:
☐ Much shorter
☐ Slightly shorter
☐ About the same
☐ Slightly longer
☐ Much longer

9. How would you rate the features in the waiting area (e.g. shelter, seating, shade) that affect your perception of waiting time?
☐ 1=Very poor
☐ 2=Poor
☐ 3=Neutral
☐ 4=Excellent
☐ 5=Very Excellent

Part III: Passenger load factor

10. On your most recent trip, how much of the shuttle's seating/capacity was occupied when you boarded?
☐Less than 25%
☐25%–50%
☐51%–75%
☐76%–100%
☐Exceeded capacity / Tight spaces

11. During peak times, how often do you find no available seat?
☐ Never
☐ Rarely
☐ Sometime
☐ Often
☐ Always

12. How comfortable do you feel with the crowding level?
    ☐ 1=Very uncomfortable
    ☐ 2=Uncomfortable
    ☐ 3=Neutral
    ☐ 4=Comfortable
    ☐ 5=Very Comfortable
13. Does crowding discourage you from using the shuttle at certain times?
    ☐ Yes
    ☐ No
14. (Optional) At which segment or stretch of the route is the shuttle most crowded?
    ☐From main gate to academic area
    ☐From academic area to dormitories / residences
    ☐Near administrative buildings
    ☐Other: _______

Part IV: Frequency and Punctuality of Shuttle Trips

15. How often (frequency) do you see a shuttle pass your stop (in your direction) during service hours?
    ☐ Every 5 minutes or less
    ☐ Every 10 minutes
    ☐ Every 15 minutes
    ☐ More than 15 minutes between shuttles
16. How many times have you experienced a shuttle arriving late relative to its schedule (in your last 5 rides)?
    ☐ 0 times
    ☐ 1 time
    ☐ 2 times
    ☐ 3 times or more
17. How punctual are the shuttle services relative to their posted schedules?
    ☐ 1 = Very poor
    ☐ 2 = Poor
    ☐ 3 = Fair
    ☐ 4 = Good
    ☐ 5 = Very good
18. In your last ride, how many minutes early or late was the shuttle compared to its schedule?
    ___ minutes early / late (write a number).
19. How reliable is the shuttle service (i.e., how often do trips deviate from schedule)?

☐ 1 = Very unreliable
☐ 2 = Unreliable
☐ 3 = Neutral
☐ 4 = Reliable
☐ 5 = Very reliable

20. If the shuttle is late, does it cause you to be late for your class/work?
☐ Yes, always
☐ Yes, sometimes
☐ No

Part V: Peak and off-peak hours of shuttle service demand

21. At what times of day (hour intervals) do you most often use the shuttle? (Check all that apply)
☐ 6AM–8AM
☐ 8AM–10AM
☐ 10AM–12NN
☐ 12NN–2PM
☐ 2PM–4PM
☐ 4PM–6PM
☐ After 6PM

22. In which time slot do you most often experience the longest wait?
☐ 6:00 – 8:00 AM
☐ 8:00 – 10:00 AM
☐ 10:00 – 12:00 NN
☐ 12:00 – 2:00 PM
☐ 2:00 – 4:00 PM
☐ 4:00 – 6:00 PM
☐ After 6:00 PM

23. Which time slot do you most often find the shuttle most crowded?
☐ 6:00 – 8:00 AM
☐ 8:00 – 10:00 AM
☐ 10:00 – 12:00 NN
☐ 12:00 – 2:00 PM
☐ 2:00 – 4:00 PM
☐ 4:00 – 6:00 PM
☐ After 6:00 PM

24. During which hours would you like more shuttle trips? (Check up to two)
☐ 6:00 – 8:00 AM
☐ 8:00 – 10:00 AM

☐ 10:00 – 12:00 NN
☐ 12:00 – 2:00 PM
☐ 2:00 – 4:00 PM
☐ 4:00 – 6:00 PM
☐ After 6:00 PM

25. (Optional) Please suggest any specific time periods when shuttle service is insufficient or should be increased: ___________

Appendix B. Summary of Key Date Results

Indicator	Dominant Response	Interpretation
Actual Waiting Time	5 – 15 minutes	Acceptable average, but inconsistent performance observed.
Expected Waiting Time	5 – 15 minutes (60%)	Aligns with user experience.
Satisfaction with Waiting Time	Neutral (53%)	Expectations unmet but normalized.
Passenger Load Exceeding Capacity	40%	Overcrowding frequently occurs.
Shuttle Punctuality	Neutral (44%)	Schedule adherence inconsistent
Instance of Delay	71% of respondents	Service Reliability issues.
Peak Usage Time	4::00 – 6:00 PM	Correspond with end-of-class hours.
Overall Satisfaction	Neutral (51%)	Indicates tolerance over satisfaction

References

1. Hrelja, R., Khan, J., & Pettersson, F. (2020). How to create efficient public transport systems? A systematic review of critical problems and approaches for addressing the problems, *Transport Policy*, 98(1), pp. 1–12.
2. Ceder, A. (2016). *Public transit planning and operation: Modeling, practice, and behavior*. CRC Press.
3. Shang, H. Y., Huang, H. J., & Wu, W. X. (2019). Bus timetabling considering passenger satisfaction: An empirical study in Beijing, *Computers & Industrial Engineering*, 135, pp. 1155–1166.
4. Zhang, A., Li, T., Zheng, Y., Li, X., Abdullah, M. G., & Dong, C. (2022). Mixed electric bus fleet scheduling problem with partial mixed-route and partial recharging, *International Journal of Sustainable Transportation*, 16(1), 73–83.
5. Schmid, V., & Ehmke, J. F. (2015). Integrated timetabling and vehicle scheduling with balanced departure times, *OR Spectrum*, 37(4), 903–928.
6. Ben-Elia, E., and Avineri, E., 2015, *response to travel information: A behavioural review*, Transport Reviews, 35(3), 352–377.
7. Fernández, R., and Tyler, N., 2020, *Effect of passenger-bus-traffic interactions on bus stop operations*, Transport Planning and Technology, 28(4), 273–292.
8. Fan, Y., Guth, D., & Levinson, D. (2015). Perception of waiting time at transit stops and stations. National Association of City Transportation Officials (NACTO). https://nacto.org/wp-content/uploads/1_Fan-et-al-Perception-of-Waiting-Time-at-Transit-Stops-and-Stations_2015.pdf
9. Napiah, M., & Kamaruddin, I. (2011). Punctuality index and expected average waiting time of bus services. Urban Transport XVII, 19, 211–221. WIT Press. https://www.witpress.com/Secure/elibrary/papers/UT11/UT11019FU1.pdf
10. TRL. (2004). Field survey techniques for urban bus operators. Transport Research Laboratory (Transport Links). https://transport-links.com/download?download_id=7363
11. Wrocław public transport passengers' satisfaction survey by means of CSI and IPA. (n.d.). ResearchGate. https://www.researchgate.net/publication/370997491_Wroclaw_public_transport_passengers'_satisfaction_survey_by_means_of_CSI_and_IPA
12. Ait-Ali, A., Eliasson, J., & Warg, J. (2023). Exploring measures to monitor passenger-centric punctuality in public transport. ResearchGate. https://www.researchgate.net/publication/387756673_Exploring_Measures_to_Monitor_Passenger-Centric_Punctuality_in_Public_Transport