INVESTIGATING PERI-URBAN CAMPUS COMMUTING PATTERNS: LEARNING FROM SUMATERA INSTITUTE OF TECHNOLOGY, LAMPUNG PROVINCE, INDONESIA

PENELAAHAN POLA PERGERAKAN MELAJU KAMPUS PERIURBAN: PELAJARAN DARI KAMPUS INSTITUT TEKNOLOGI SUMATERA, PROVINSI LAMPUNG

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ABSTRACT

This paper studies the commuting patterns of students and staff at the Sumatera Institute of Technology (ITERA), a rapidly growing university located in a peri-urban area of Lampung Province, Indonesia. The research is grounded in the understanding that peri-urban commuters face unique mobility challenges shaped by transitional land use, limited infrastructure, and high motorcycle dependency. Using both statistical and spatial analyses, the article analyzed distinct travel behaviors and their socioeconomic determinants. Findings reveal that motorcycles dominate as the primary commuting mode for both groups, driven by cultural norms and constrained public transport access. Staff exhibit higher rates of vehicle ownership and longer, more dispersed commutes, while students tend to reside closer to campus and rely on borrowed motorcycles. Temporal analysis shows structured weekday travel among staff and more flexible, weekend-active patterns among students. The findings offer targeted insights for developing sustainable transportation strategies in rapidly expanding peri-urban institutions—such as promoting bicycle and pedestrian infrastructure, designing transport policies that account for widespread motorcycle borrowing among students, and differentiating mobility interventions based on the spatial dispersion and financial profiles of staff versus students.

Keywords: Commuting Patterns, Peri-Urban Mobility, Sustainable Transportation, Socioeconomic Factors, Sumatera Institute of Technology (ITERA)

ABSTRAK

Penelitian ini mempelajari pola perjalanan mahasiswa dan staf di Institut Teknologi Sumatera (ITERA), sebuah universitas yang berkembang pesat yang terletak di daerah pinggiran kota Provinsi Lampung, Indonesia. Penelitian ini didasarkan pada pemahaman bahwa para komuter pinggiran kota menghadapi tantangan mobilitas yang unik yang dibentuk oleh penggunaan lahan yang bersifat transisi, infrastruktur yang terbatas, dan ketergantungan yang tinggi pada sepeda motor. Dengan menggunakan analisis statistik dan spasial, artikel ini menganalisis perilaku perjalanan yang berbeda dan determinan sosial ekonominya. Temuan penelitian mengungkapkan bahwa sepeda motor mendominasi sebagai moda perjalanan utama bagi kedua kelompok, didorong oleh norma budaya dan akses transportasi umum yang terbatas. Staf menunjukkan tingkat kepemilikan kendaraan yang lebih tinggi dan perjalanan yang lebih lama dan lebih tersebar, sementara mahasiswa cenderung tinggal lebih dekat ke kampus dan bergantung pada sepeda motor pinjaman. Analisis temporal menunjukkan perjalanan hari kerja yang terstruktur di antara staf dan pola yang lebih fleksibel dan aktif di akhir pekan di antara mahasiswa. Temuan ini menawarkan kebijakan yang terarah untuk mengembangkan strategi transportasi berkelanjutan di lembaga-lembaga pinggiran kota yang berkembang pesat—seperti mempromosikan infrastruktur sepeda dan pejalan kaki, merancang kebijakan transportasi yang memperhitungkan peminjaman sepeda motor yang meluas di kalangan mahasiswa, dan membedakan intervensi mobilitas berdasarkan penyebaran spasial dan profil keuangan staf versus mahasiswa.

Kata Kunci: Pola Perjalanan, Mobilitas Pinggiran Kota, Transportasi Berkelanjutan, Faktor Sosial Ekonomi, Institut Teknologi Sumatera (ITERA)

1. INTRODUCTION

The global phenomenon of urbanization has accelerated the growth of peri-urban areas—transitional zones between urban and rural landscapes—characterized by dispersed development, evolving land use, and infrastructural challenges (Ravetz et al., 2013; Ravetz & Sahana, 2025). These settings create unique mobility dynamics for residents and institutions situated within them. In particular, the movement patterns of peri-urban commuters are influenced by limited access to public transportation, high dependency on motorcycles, and fragmented spatial layouts (Baye, 2025; Poku-Boansi et al., 2018).

Universities located in peri-urban areas play a critical role as anchor institutions (Harris & Holley, 2016), often catalyzing regional development while simultaneously generating complex mobility demands. Yet, much of the existing research on university commuting behavior focuses on established institutions in dense urban settings, especially in the Global North (e.g., Limanond et al., 2011; Moniruzzaman & Farber, 2018; Vale et al., 2018). These studies frequently overlook the distinct commuting patterns that emerge in newer, rapidly growing universities embedded in the peri-urban fabric of Southeast Asian cities. Existing research has provided valuable insights into factors influencing university commuting, such as gender, vehicle ownership (Limanond et al., 2011), the role of transit passes and bike ownership (Moniruzzaman & Farber, 2018), the impact of harsh weather and inadequate public transit (Hamad et al., 2021), and the influence of the built environment, including parking availability and accessibility (Vale et al., 2018). Studies have also contrasted student travel with that of the general population, noting students' higher trip rates and preference for alternative modes outside peak hours (Khattak et al., 2011), the impact of vehicle availability on mode choice (Wang et al., 2012), and seasonal variations in travel preferences (Delmelle & Delmelle, 2012). Despite these contributions, a significant gap persists in understanding how these commuting patterns and their determinants manifest in the specific context of rapidly developing peri-urban areas within Southeast Asia. This region is characterized by distinct socioeconomic conditions, cultural norms regarding transportation (such as high motorcycle prevalence), and often, a lag in public infrastructure development compared to the pace of institutional and population growth. The Sumatera Institute of Technology (ITERA), located in Lampung Province, Sumatra Island, Indonesia, exemplifies such an institution.

The objective of this paper is to investigate the commuting patterns within ITERA, a rapidly expanding university in a peri-urban area of Indonesia, a developing Southeast Asian country. This research is important because it establishes a crucial baseline understanding of current travel behaviors, modal split, trip purposes, and socioeconomic influences at ITERA, where such detailed data is currently missing. This baseline is necessary for any future, more complex studies or policy decisions. By focusing on Indonesia, the research also addresses a specific regional gap, offering vital insights into transportation in an area where commuting habits, like the common use of motorcycles, are very different from those in Western countries where much transport research comes from. This helps provide a broader, less Western-centric view of university travel. Furthermore, the study highlights the unique transportation challenges faced in peri-urban areas—such as limited public transport, spread-out housing, and changing land use—which differ from those in established urban university settings, offering lessons for similar institutions. Even without making predictions, the findings directly point to areas where targeted actions can encourage more sustainable and efficient transport, providing immediately useful information for ITERA's campus planners and local transport authorities.

2. DATA AND METHODS

2.1. Study Location

The Sumatera Institute of Technology (ITERA), located in Lampung Province, Sumatra Island, Indonesia (Figure 1), is the primary study location for this research, owing to its characteristic as a campus situated in a peri-urban area. As a relatively new university, ITERA has experienced remarkable growth, with its student population doubling between 2019 and 2023 to over 19,000, alongside a slower but steady increase in academic staff (Figure 2). This rapid expansion is situated within a peri-urban landscape, a

characteristic visually underscored by Figure 1, which depicts a noticeable difference in building density between the urban core of Bandar Lampung City and the less densely developed Lampung Selatan Regency where ITERA is located.
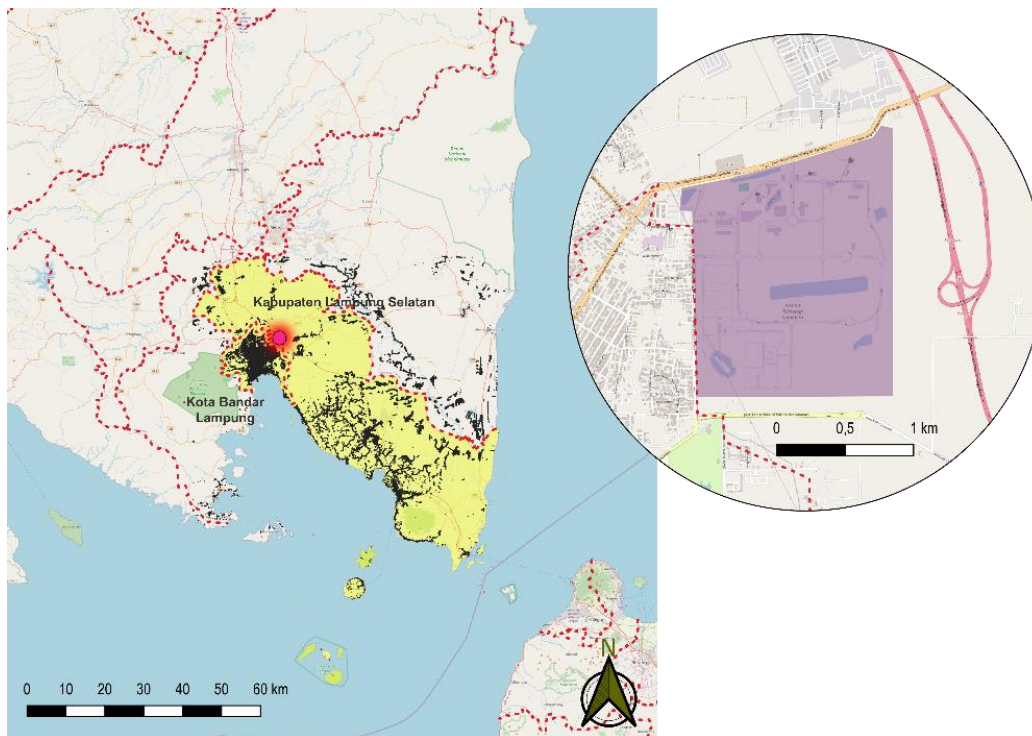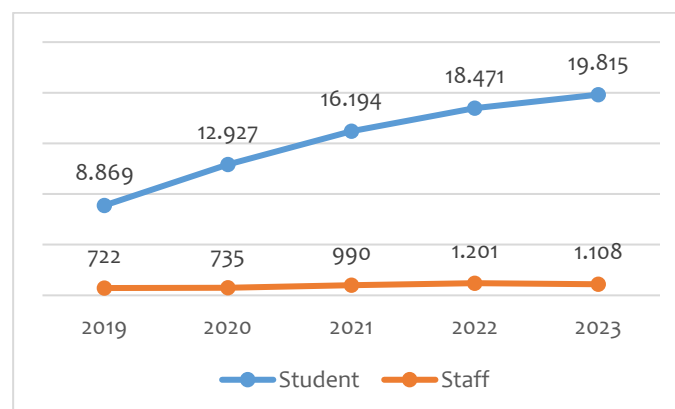

Figure 1. ITERA Campus Location

Figure 2. ITERA Development Characterized by the Number of Students and Staff in 4 Years Since 2019

2.2. Methods

This paper employs both descriptive and inferential statistics, along with spatial analysis, to investigate the movement patterns of peri-urban campus commuters. Descriptive statistics are utilized to reveal the socioeconomic characteristics of the sampled staff and students, who represent peri-urban campus commuters. These characteristics include gender proportion, average age, median number of vehicles owned, and average weekly travel costs. Furthermore, this analysis also calculates variables pertinent to movement patterns, such as the average travel speed for each group, and the temporal distribution of trip proportions based on their purpose. Inferential statistical analyses, specifically the

estimation of proportion/mean parameters (confidence intervals, c.i., Eq. 1 and Eq. 2) and t-test, are applied to project these descriptively calculated parameters onto the entire population of staff and students who commute to the ITERA campus. All of the statistical analysis are done in Microsoft Excel.

$$\text{c.i. of proportion} = \hat{p} \pm 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \qquad \text{Eq. 1}$$

$$\text{c.i. of mean} = \bar{x} \pm 1.96 \frac{\text{sd}}{\sqrt{n}} \qquad \text{Eq. 2}$$

Where c.i. = Confidence Interval; $\hat{p}$ = Sample Proportion; sd = Sample Standard Deviation; n = Sample Size

This methodology aligns with approaches used in similar studies, such as those by Limanond et al. (2011), who utilized statistical tests such as t-tests and ANOVA to examine characteristic differences between male and female students, both motor vehicle owners and non-owners, at a university in rural Thailand and Khattak et al. (2011) to model travel demand for students at campuses in Virginia, United States.

In addition to statistical analysis, spatial analysis was used to evaluate the impact of residential location on trip patterns. Respondents provided the names of their residential streets, which were geocoded using Google Maps to obtain precise coordinates. Using road network and building data from OpenStreetMap, network analysis was performed using ORS Tools in QGIS to calculate actual travel distances along the road network between residences and the campus and also identify the peri-urbanism building density. This method allowed for a more accurate reflection of commuting patterns by accounting for actual travel routes, rather than straight-line (Euclidean) distances. This spatial approach is consistent with established methodologies in similar studies, providing a robust foundation for our analysis. For example, Limanond et al. (2011) similarly incorporate GIS tool to estimate respondents' travel distances, thereby enhancing their statistical analysis of travel patterns. Our integration of spatial analysis to investigate commuting patterns influenced by the built environment further aligns with the work of Vale et al. (2018). The following diagram in Figure 3 illustrates the research methodology employed in this article.
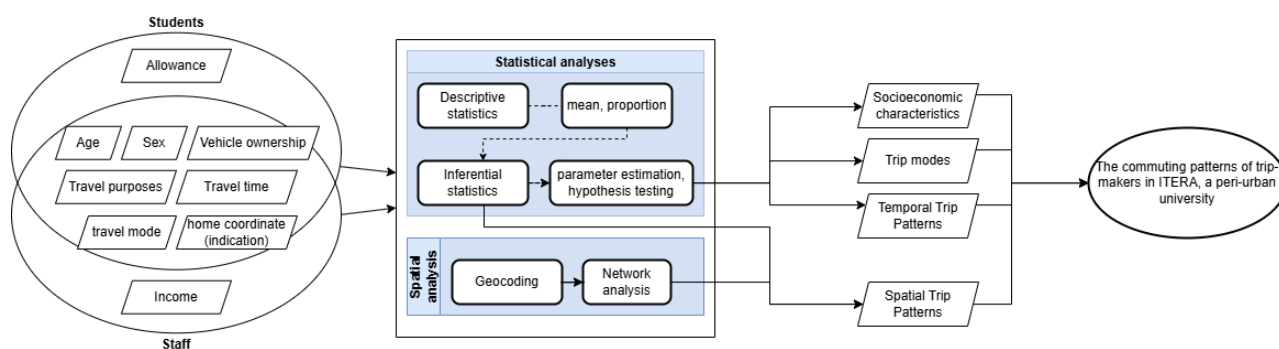

Figure 3. Methodology Diagram for this Paper

2.3. Data

To facilitate these analyses, questionnaires were distributed to students and staff using a non-probabilistic sampling method, specifically quota sampling. This approach was selected to ensure balanced representation across various academic programs and faculties within the institution. The sampling was conducted from a total population of 18,877 students and 995 staff members recorded at ITERA in early 2024. The total sample collected (*n = 715*) comprised 429 students and 286 staff members, distributed across

42 study programs within 3 faculties. These sample sizes were determined using Slovin's formula (Eq. 3), based on the population numbers (N) and a 5% margin of error (e), providing a practical estimation for this large population.

$$n = \frac{N}{1+N(e^2)}$$
Eq. 3

3. RESULT AND DISCUSSION

3.1. Peri-Urban Campus Commuting Patterns in Sumatera Institute of Technology

This section presents the results of the analysis and the subsequent discussion of these findings. The analytical results displayed include, first, the socioeconomic characteristics of the ITERA student and staff populations, comprising average age, types of vehicles owned, and monthly travel expenses, all disaggregated by gender (male and female). The second set of analytical results pertains to movement patterns, covering trip mode, temporal patterns, and spatial patterns. The discussion section elaborates on these analytical findings to elucidate commuter movement patterns at ITERA, given its location in a peri-urban area.

3.1.1. Socioeconomic Characteristics

Out of 429 students and 286 staff we observed, the analysis of age demographics reveals a significant age gap, with staff being about nine years older than students. This disparity, along with the gender distribution, influences travel behaviors, as older staff members may prefer more reliable transport modes, shaping traffic patterns at ITERA. The greater age variability among staff also suggests diverse commute times and preferences, potentially impacting peak travel periods. In contrast, the age homogeneity of students leads to more synchronized travel, reflecting standardized academic schedules.

The analysis of vehicle ownership among staff and students reveals distinct transportation preferences. Staff members predominantly own motorcycles, as evidenced by a median ownership of 1 and a population confidence interval ranging from 1.06 to 1.19, indicating consistent motorcycle use among this group. In contrast, motorcycles are notably less common among students, with none owning motorcycles in the sample and the population confidence interval suggesting minimal ownership (0.09 – 0.43). On the other hand, car ownership is exclusively found among students, where the median is 1 with a population confidence interval of 0.73 to 0.79, highlighting a strong preference for cars among students who own vehicles. Staff show some potential for car ownership (population confidence interval 0.31 – 0.43), but this is not reflected in the sample. Bicycles are not significantly owned by either group, with zero median ownership. However, the population confidence interval for staff (0.23 – 0.36) and students (0.18 – 0.60) suggests a minor yet notable interest, indicating an underutilized opportunity for promoting bicycles as a sustainable mode of travel. These ownership patterns underscore the practical or economic factors influencing staff's transportation choices and the different socioeconomic backgrounds or travel needs of students.

Further analysis of vehicle ownership among staff and students reveals distinct transportation preferences, though it appears there may be some misunderstanding among students regarding motorcycle ownership. While no motorcycles are registered as owned in the sample, a significant portion of students (60.60%, Figure 4) identify private motorcycles as their primary means of commuting, suggesting they consider these vehicles as borrowed because they originate from their family homes. This misunderstanding not only indicates a discrepancy between actual usage and perceived ownership but also points to an increase in the number of vehicles immigrating to South Lampung, particularly around the ITERA area. Conversely, staff members predominantly own motorcycles, with a median ownership of 1 and a consistent usage pattern indicated by the population confidence interval. Car ownership is more prevalent among students, aligning with a median of 1 and supporting the notion that those who own vehicles tend to prefer

cars. Bicycles show a lower ownership rate with a potential for greater utilization, hinted at by the population confidence intervals for both staff and students. These insights into vehicle ownership and usage patterns not only highlight the economic and practical factors influencing transportation choices but also reflect the differing perceptions and realities of vehicle ownership between staff and students.

Table 1. Staff and Students' Socioeconomic Descriptive Statistics and Population Estimates

Variable	Staff		Students	
	Sample	Population (95% c.l. Interval Estimation)	Sample	Population (95% c.l Interval Estimation)
Mean of age in year (s.d. in the parentheses)				
Male	30.37 (3.68)	29.94 – 30.80	21.13 (1.09)	21.03 – 21.24
Female	29.50 (2.48)	29.22 – 29.80	20.67 (1.12)	20.56 – 20.77
Median of vehicle ownership number (parameter estimation uses mean)				
Motorcycle	1	1.06 – 1.19	0	0.09 – 0.43
Car	0	0.31 – 0.43	1	0.73 – 0.79
Bicycle	0	0.23 – 0.36	0	0.18 – 0.60
Generalized weekly out-of-pocket travel cost in Rupiah (s.d in the parentheses)				
Male	99,959 (112,263)	86,948 – 112,970	36,023 (32,909)	32,909 – 42,468
Female	77.742 (67,136)	69,961 – 85,523	41,211 (46,064)	36,853 – 45,568

Turning to the final variable in our socioeconomic analysis, we examine the generalized weekly out-of-pocket costs for staff and students at ITERA, providing insights into distinct financial behaviors within the academic community. Staff have a wider population estimate, ranging from 76,880 to 97,714 rupiah, compared to students, whose range is from 34,864 to 42,468 rupiah. This suggests that there is a relatively wide range of spending among staff members, possibly reflecting the varied roles and salaries within this demographic. In contrast, students display a more consistent spending pattern, likely reflecting their generally more uniform financial status and lifestyle. Understanding these differences in spending can be crucial for campus administrators when considering services and support systems that cater to the distinct travel needs of staff and students.

Based on the analysis of socioeconomic characteristics, gender distribution, age demographics, vehicle ownership, and financial behaviors, several important insights emerge regarding the travel patterns of ITERA students and staff. The nearly balanced gender ratio for both students and staff, coupled with the significant age difference, influences the distinct commuting habits of these two groups. Staff, who are on average older, display a preference for motorcycles due to their reliability, whereas students show a mix of car and motorcycle use, often borrowing motorcycles from their families. This divergence in vehicle ownership points to differences in economic capacity and practical considerations between the groups. Additionally, the observed variation in out-of-pocket travel costs highlights the differing financial contexts of staff and students, with staff having more variability in their expenses, likely due to varied family responsibilities and income levels. Taken together, these findings illustrate the complex interplay of age, gender, financial status, and transportation preferences that shape the commuting dynamics at ITERA, suggesting the need for tailored policies that consider these unique needs to improve campus mobility and sustainability.

3.1.2. Mobility Patterns
3.1.2.1. Commuting modes
The analysis of trip mode from Figure 3 reveals that both staff and students at ITERA predominantly utilize motorcycles for commuting, indicating that motorcycles are a favored mode of transportation on campus. However, a higher proportion of staff members use motorcycles compared to students, as evidenced by the greater confidence interval for the staff population proportion (0.64 – 0.75 vs. 0.56 – 0.65).

A similar trend is observed for car usage, with approximately 0.15 – 0.25 of all staff members using cars, compared to 0.02 – 0.06 of all students. Income level, as a key socioeconomic variable, significantly influences travelers' mode choice (Andani & Vinishaumi, 2024). This is reflected in the higher propensity of staff, a group with relatively higher income compared to students, to own motorized private vehicles. This characteristic also aligns with the typical lack of public transportation availability in peri-urban areas (Adu-Gyamfi, 2020). The influence of income on mode choice is further evident in the higher proportion of students using non-private vehicle modes compared to staff, such as ride-sharing, online transportation, and walking, which further underscores the insufficient movement facilities in peri-urban areas.
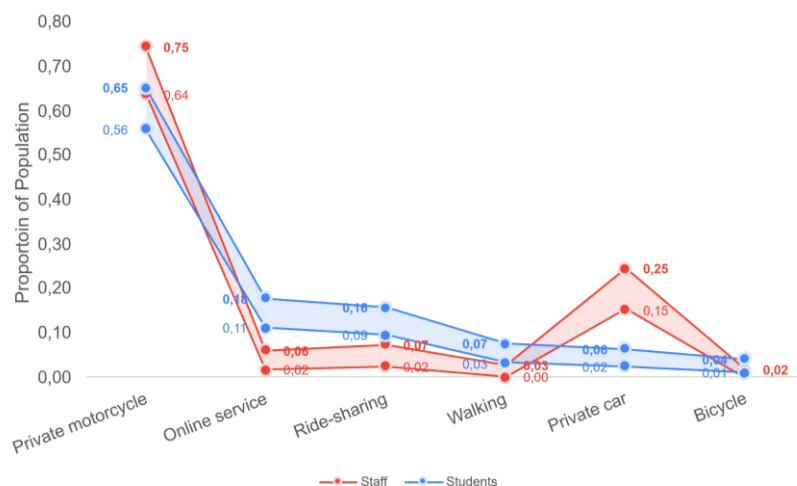

Figure 4. Estimation of Students' and Staff Mode of Commuting Proportion

3.1.2.2. Temporal patterns

On weekdays, as shown in Table 2, the average trip rates for both students and staff is similar, ranging from 2.30 to 2.52. However, on weekends, students tend to travel significantly more than staff, with an increase of nearly 48% (2.38 vs. 1.61). This aligns with the results of the two-population hypothesis test for weekday trips using a t-test, which yielded a p-value greater than 0.05 (0.23), whereas the weekend p-value was less than 0.05 (1.1×10^{-8}), meaning that on weekdays we failed to reject null-hypothesis, suggesting no significant difference in trip rates between students and staff, unlike on weekends, where the null hypothesis was successfully rejected.

Table 2. Staff and Students Trip Rate Descriptive Statistics and Population Estimates,
Both Daily and in Weekdays-Weekends

Day	Average		S.d.		two-population t-test
	Student	Staff	Student	Staff	
Monday	2.46	2.35	1.23	0.86	Weekdays:
Tuesday	2.40	2.29	1.24	0.78	• t-Stat: -0.7143
Wednesday	2.30	2.21	1.29	1.01	• df: 684
Thursday	2.30	2.31	1.29	0.81	• p-value (1-tail): 0.23
Friday	2.45	2.52	1.54	1.10	
Saturday	1.15	0.81	1.34	1.09	Weekend:
Sunday	1.23	0.79	1.36	1.17	• t-Stat: -5.66205
Weekdays	*11.90*	*11.69*	*4.44*	*3.63*	• df: 678
Weekend	*2.38*	*1.61*	*1.98*	*1.65*	• p-value (1-tail): 1.1×10^{-8}

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Overall, as shown in the box plots in Figure 5, both the total number of trips and the average trip rate reveal more noticeable differences between students and staff on weekends. This indicates that ITERA students are more likely to travel on weekends compared to staff. This is understandable given the different socioeconomic characteristics of students and staff: students are often unmarried and thus have more freedom, while staff members are more likely to have family responsibilities, which reduces their likelihood of traveling. Many students also live away from their families in boarding houses, giving them fewer reasons to stay indoors. On the other hand, most staff are married and prefer to spend their weekends at home with their families, especially after a busy workweek. Additionally, staff members are likely to have more household responsibilities, as many are in their 30s, an age often associated with starting a family or having young children, which takes up much of their time for home-based activities rather than going out.
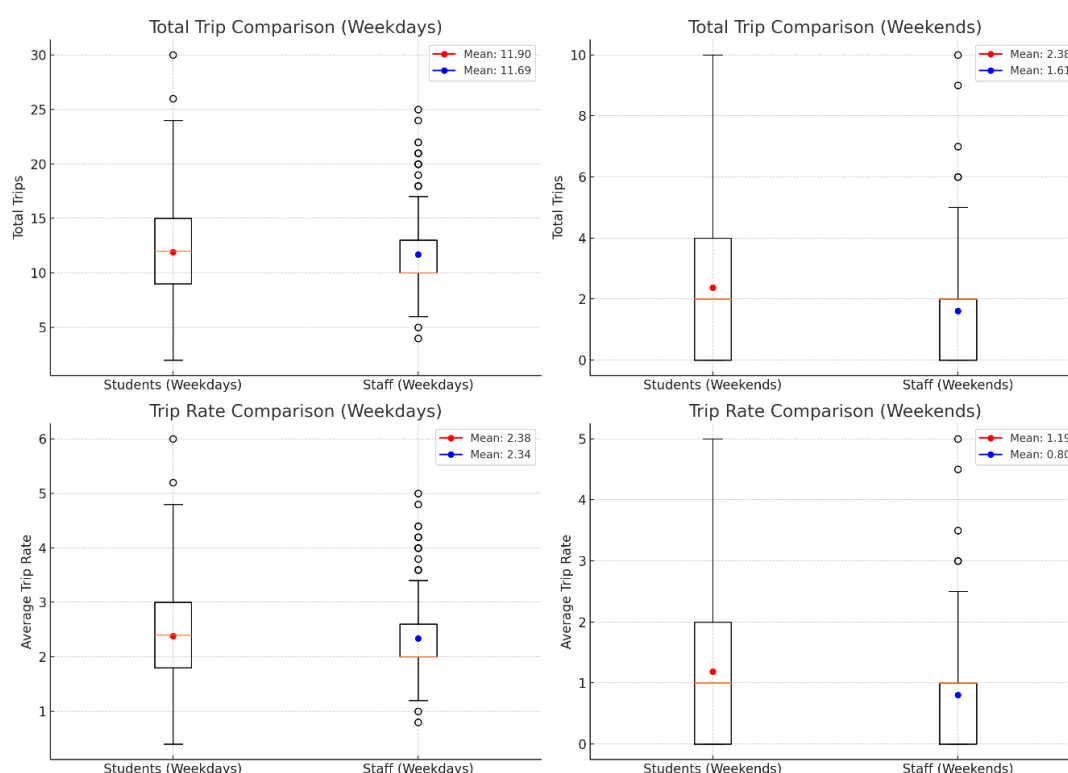

Figure 5. Comparison of Students and Staff Amount of Trips in Weekdays and Weekends

The temporal distribution also reveals distinct differences in travel patterns between staff and students. The charts in Figure 6 show that students' home-based trips are more evenly spread throughout the day. The blue and red dashed lines in the student travel chart illustrate that students depart to campus and return home at various times throughout the day, which aligns with the nature of their campus activities that can occur at almost any time depending on their class schedules. Students usually return home after their classes are finished. This is also found by Limanond et al. (2011) that students at Suranaree University of Technology in Thailand were more likely to travel during the nighttime compared to staff.

In contrast, staff members show a more uniform pattern, with a peak in inbound trips (represented by the brown, full line in Figure 7) around 7 AM and a peak in outbound trips (represented by the red, full line) around 4-5 PM. This finding reflects the nature of regular and fixed work schedule of campus staff (Cheu et al., 2021). This is also supported by the findings by Hamad et al. (2021) regarding Sharjah University City in the UAE, where staff trips were concentrated in the morning and late afternoon, while student trips were more spread throughout the day. Limanond et al. (2011) also found that students at SUT in Thailand were more likely to travel during the nighttime compared to staff.
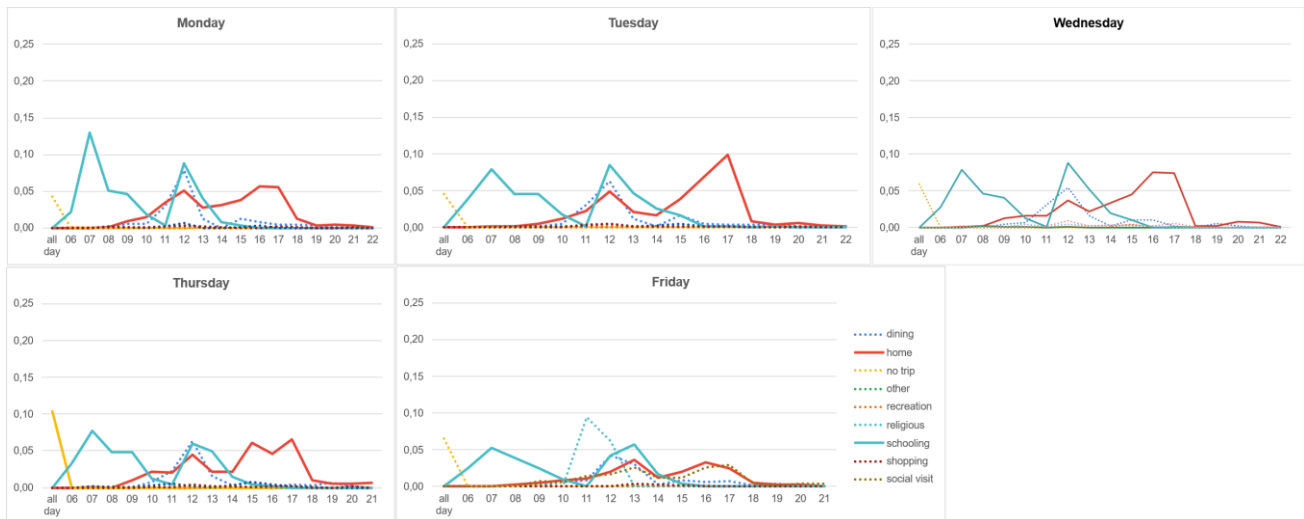
Figure 6. Students' Weekdays Temporal Trip Distributions by Purposes
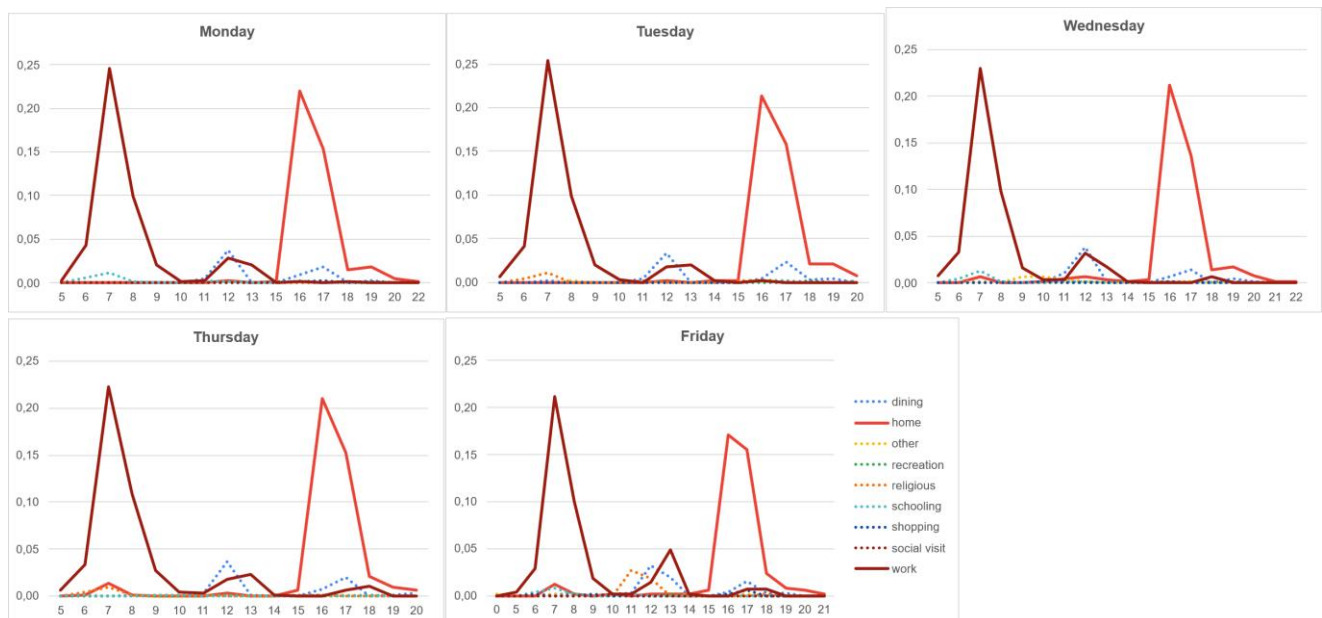(y-axis: Proportion of Number of Trips)

Figure 7. Staff's Weekdays Temporal Trip Distributions by Purposes
(y-axis: Proportion of Number of Trips)

During weekends, students also demonstrate higher travel activity compared to staff (Figure 8). Peak student travel volumes on weekends can reach twice the peak levels of staff travel (approximately 50 trips compared to 25 trips). The purposes of travel also differ, particularly for dining out. Students' dining activities start earlier, as early as 7 AM, and persist until late evening, past 9 PM. Staff, on the other hand, predominantly begin dining activities around 11 AM, aligning with lunchtime. On both weekend days, students exhibit two dining peaks: midday (around 12-1 PM) and evening (around 7 PM). Staff, however, show only one peak for dining out during midday. On Sundays, staff engage in dining-out activities, but these are not as pronounced as their midday peaks.

These findings illustrate that students are generally more active on weekends compared to staff. This aligns with observations which noted distinct patterns of activity among students, staff, and faculty

members (Joumblat et al., 2024). The higher mobility of students during weekends can be linked to their flexible schedules and social lifestyles, whereas staff prioritize family and household commitments during this time.
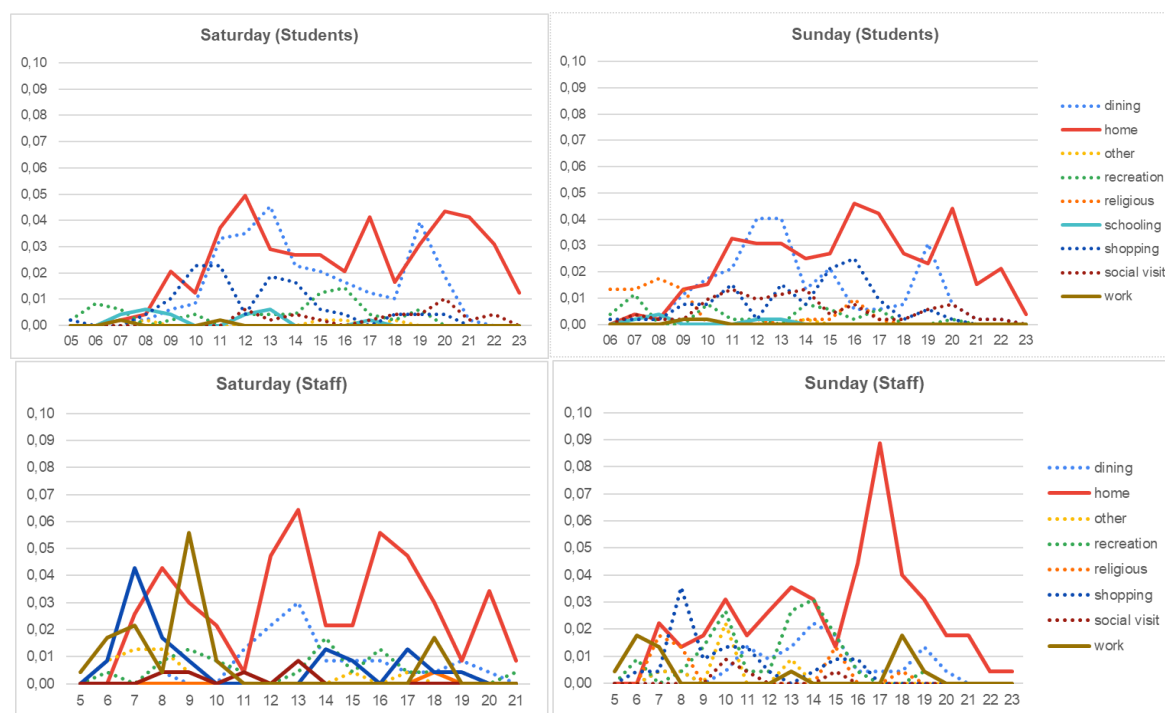

Figure 8. Weekend Temporal Trip Distribution of Students (Above) and Staff (Below) by Purposes

3.1.2.3. Spatial patterns

Independent two-sample t-test was conducted to compare the commuting trip distances of students and staff. Table 3 summarizes the descriptive statistics and the results of the independent samples t-test comparing the two groups.

Table 3. Statistics of Students and Staff Commuting Distance

Trip Distance (km)	Students	Staff
Mean (M)	5.01	7.89
Std. Dev (SD)	2.82	6.42
Degree of freedom		712
t-Statistic		-8.188
p-value		6.12×10^{-16}

On average, staff members reported significantly longer trip distances (M = 7.89 km, SD = 6.42 km) compared to students (M = 5.01 km, SD = 2.82 km). The variability in trip distance was also notably greater for staff, as indicated by a larger standard deviation. An independent samples t-test was performed to determine if the difference in mean trip distances between students and staff was statistically significant. The results indicated a highly significant difference, $t(712)$ = -8.188, p = 6.12 × 10⁻¹⁶. Given the extremely small p-value, which is well below conventional alpha levels (e.g., α = 0.05 or 0.01), we can conclude that ITERA staff commute significantly longer distances to the campus than students.

The spatial distribution of commute origins, as depicted in Figure 9, provides a compelling visual corroboration of the statistical findings regarding trip distances presented earlier (Table 3). The map illustrates that student origin points (red dots) are predominantly clustered in closer proximity to the ITERA

campus, largely within the denser urban fabric of Kota Bandar Lampung and the immediately surrounding areas of Lampung Selatan. This dense clustering visually supports the shorter average trip distance (5.01 km) and lower variability (SD 2.82 km) for students. Conversely, while many staff origin points (light blue dots) are also located within Kota Bandar Lampung, a noticeable proportion is dispersed more widely across Lampung Selatan and extend into more distant regencies like Pesawaran, Lampung Tengah, and Lampung Timur, often in areas with sparser building footprints. This broader geographical spread of staff residences directly aligns with their significantly longer average commuting distance (7.89 km) and the greater standard deviation (SD 6.42 km) observed in the table, reflecting a more heterogeneous and extensive commuter zone for staff members.
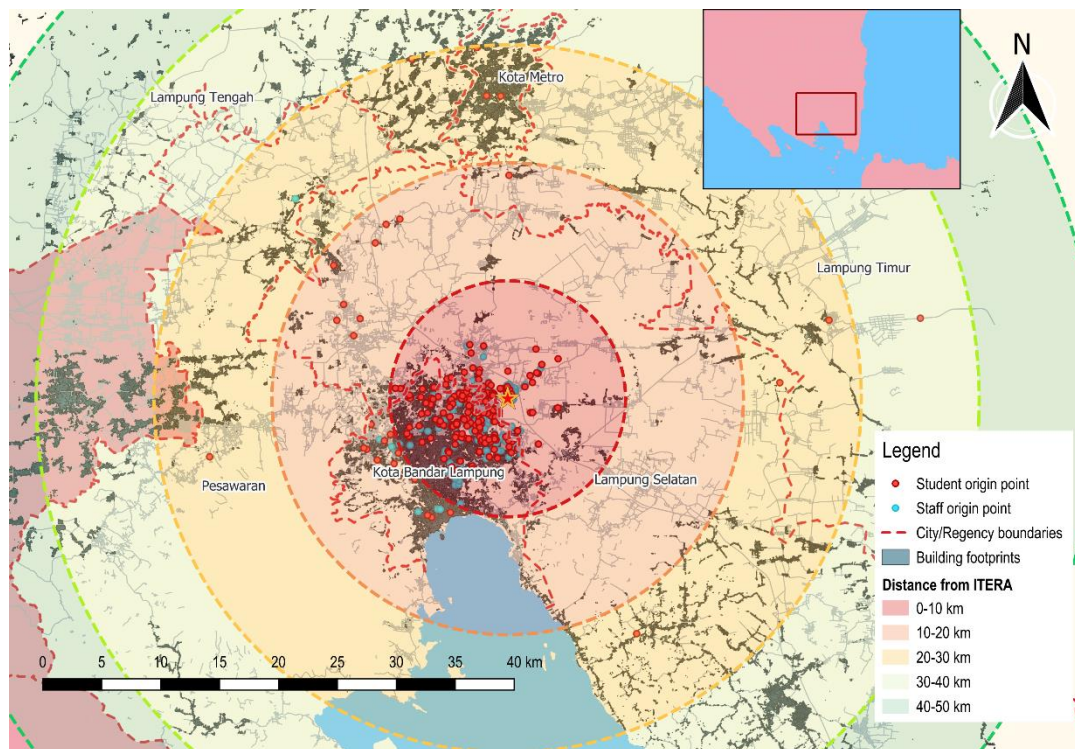

Figure 9. Spatial Distribution of Student and Staff Commute Origin Points Relative to the ITERA Campus, Overlaid on Building Footprints and Administrative Boundaries in Lampung Province

3.2. Dynamics of Peri-Urban Campus Commuting Pattern

The peri-urban setting of the Sumatera Institute of Technology (ITERA) plays a critical role in shaping the commuting behaviors of its academic community. Peri-urban areas, often characterized by a transitional landscape between rural and urban environments, exhibit unique transportation challenges and opportunities (Baye, 2025), particularly in university contexts (Volosin et al., 2014). The rapid development of such areas, often accompanied by inadequate transportation infrastructure and evolving land use, creates distinct commuting patterns that differ from those observed in urban or rural settings.

3.2.1. Peri-urban Characteristics and University Commuting

Peri-urban universities like ITERA are frequently located on the outskirts of cities to accommodate large land requirements for campus development. This location presents challenges, including limited public transportation options, poor road conditions, and dependence on motorized private vehicles (Vasconcelos et al., 2025). These issues are echoed in studies such as those by Limanond et al. (2011) and Hamad et al. (2021), which highlight that universities situated in peri-urban areas tend to have a higher reliance on

personal vehicles compared to institutions in urban centers with well-developed transit networks. At ITERA, motorcycles dominate as the primary commuting mode, reflecting the limited availability and reliability of public transportation in its peri-urban setting (Poku-Boansi et al., 2018).

The proximity of residential areas to campus influences commuting choices. Despite their closeness, students at ITERA often rely on motorcycles rather than walking or cycling, a pattern consistent with findings by Wang et al. (2012), who observed a preference for motorized modes among students in peri-urban campuses in Virginia, USA. This reliance highlights the need for improved pedestrian and cycling infrastructure to encourage non-motorized transportation. Furthermore, the spatial dispersion of residential areas in peri-urban zones necessitate network-based travel solutions, as seen in this study's use of geocoded residential data and road network analysis, aligning with methodologies used by Vale et al. (2018) in examining commuting patterns influenced by campus locations.

3.2.2. Socioeconomic Dynamics in Peri-urban Areas

The socioeconomic characteristics of peri-urban university communities further shape transportation behaviors. The demographic diversity of students in peri-urban universities often includes a significant proportion from lower- to middle-income backgrounds, which influences their transportation choices. At ITERA, many students reported commuting with motorcycles that are not registered under their ownership but are borrowed from friends reflecting practical adaptations to limited financial resources. This pattern underscores a broader socioeconomic constraint affecting mode choice. Similar findings by Moniruzzaman & Farber (2018) show that students' access to sustainable or alternative transport options is strongly shaped by their income levels and household support structures. Staff members in peri-urban universities often have more stable incomes and higher vehicle ownership rates than students, as seen at ITERA. However, their preference for motorcycles over cars reflects practical considerations, including cost-effectiveness and ease of navigation in congested areas (Musso et al., 2010). This trend differs from findings in urban universities, where staff often opt for cars due to better parking availability and road infrastructure (Rérat, 2021).

3.2.3. Temporal Travel Behavior and Peri-urban Context

The temporal distribution of travel in peri-urban settings is influenced by both geographic and institutional factors. Peri-urban universities, often lacking robust public transit (Adu-Gyamfi, 2020), see peak commuting times concentrated around academic schedules and work hours. At ITERA, staff demonstrate predictable morning and afternoon commuting patterns, while students exhibit more varied travel times due to flexible schedules. Similar patterns were observed by Hamad et al. (2021) in Sharjah University City, where students traveled throughout the day, while staff had structured travel routines. Weekend travel patterns in peri-urban areas differ significantly from urban contexts. At ITERA, students' higher mobility during weekends reflects their social lifestyles and need to access amenities not readily available in peri-urban zones. This contrasts with findings in urban campuses, where students' weekend travel is often lower due to better on-campus facilities and access to nearby urban services (Wang et al., 2012). The ITERA case highlights the importance of integrating social and recreational spaces into campus design to reduce unnecessary travel.

3.2.4. Implications for Transportation Planning in Peri-urban Universities

The unique transportation challenges of peri-urban universities demand tailored solutions. This study's findings underscore the need for policies that address the reliance on motorcycles and the underutilization of sustainable modes like bicycles. Investments in cycling infrastructure, enhanced pedestrian pathways, and subsidized public transit are essential to reduce environmental impacts and improve accessibility. These interventions align with recommendations by Vale et al. (2018), who emphasize the role of integrated planning in promoting sustainable transport in peri-urban campuses. Additionally, transportation planning in peri-urban settings must account for the evolving nature of these areas. As peri-urban zones develop, increased traffic and environmental pressures necessitate proactive strategies, such

as limiting parking availability to discourage private vehicle use and introducing campus shuttle services. Such measures have proven effective in urban contexts Moniruzzaman & Farber (2018) and can be adapted to peri-urban settings with appropriate modifications.

4. CONCLUSION

This paper successfully identified and compared the distinct commuting patterns of students and staff at the Sumatera Institute of Technology (ITERA), fulfilling its objective by analyzing these behaviors against key socioeconomic and spatial factors within a rapidly developing peri-urban context. The findings revealed a shared reliance on motorcycles as the primary commuting mode for both groups, a choice influenced by cultural norms, economic factors, and the limited public transport typical of its peri-urban setting. This reliance is nuanced by differing vehicle access, with staff exhibiting higher direct ownership rates while many students use motorcycles borrowed from friends, reflecting economic disparities and practical needs. Spatially, a clear divergence emerged: students predominantly reside in denser clusters closer to campus, resulting in significantly shorter and less varied commute distances. In contrast, staff commutes are, on average, longer and originate from a more geographically dispersed and heterogeneous commuter zone, indicating greater variability in their residential choices.

Temporally, weekday travel for staff adheres to structured work schedules, creating distinct morning and afternoon peaks, whereas students' travel is more evenly distributed throughout the day due to flexible academic timetables. This distinction extends to weekends, where students demonstrate markedly higher mobility, primarily for social and recreational activities, unlike staff, whose weekend travel is less frequent and often family oriented. These multifaceted commuting behaviors are intrinsically linked to the demographic profiles (notably age differences), financial capacities, and vehicle ownership patterns of each group. Critically, all these patterns are shaped by ITERA's specific peri-urban environment, characterized by dispersed residential areas, evolving land use, and a significant lag in public infrastructure development, which collectively underscore the unique transportation dynamics and challenges faced by such rapidly growing institutions in Southeast Asia.

For practitioners and campus administrators, the findings highlight the importance of accommodating informal vehicle use—such as student reliance on borrowed motorcycles—and the need for differentiated mobility strategies based on user groups. For instance, staff commuting from dispersed peri-urban areas may benefit from structured shuttle services or ride-sharing programs, while students closer to campus could be supported through improved pedestrian and cycling infrastructure. Furthermore, the spatial analysis offers a data-driven approach for identifying mobility gaps and targeting infrastructure improvements. Academically, this paper fills a notable gap in the literature by focusing on the under-researched context of Southeast Asian peri-urban universities, offering empirical evidence that can inform both future research and regional policy development on sustainable campus mobility.

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