Preprints.org

Article

Assessment of Sustainable Mobility Patterns of University Students and Staff: Case of a LMIC

Stephen Kome Fondzenyuy [*] , Isaac Ndumbe Jackai II , Steffel Ludivin Feudjio Tezong , Davide Shingo Usami , Brayan Gonzalez-Hernandez , Jean François WOUNBA , George NKENG ELAMBO , Luca Persia

Article

Assessment of Sustainable Mobility Patterns of University Students and Staff: Case of a LMIC

Stephen K. Fondzenyuy [1,*], Isaac Ndumbe J. [2], Steffel F. Tezong [1], Davide S. Usami [1], Brayan Gonzalez [1,2], Wounba J. Francois [2], Nkeng G. Elambo [1] and Luca Persia [2]

[1] Centre of Research for Transport and Logistics, Sapienza University of Rome, Via Eudossiana 18, Rome 00184, Italy; steffelludivin.feudjiotezong@uniroma1.it (S.F.T.); davideshingo.usami@uniroma1.it (D.S.U.); brayan.gonzalez@uniroma1.it (B.G.); gnkeng@yahoo.com (N.G.E.)

[2] Department of Transport Planning, National Advanced School of Public Works, Yaoundé, i_ndumbe@yahoo.com (I.N.J.); Jfwounba@gmail.com (W.J.F.); luca.persia@uniroma1.it (L.P.)

* Correspondence: stephenkome.fondzenyuy@uniroma1.it

Abstract: The transition to sustainable mobility is a recognized socio-economic and environmental challenge, particularly among young adults in low- and middle-income countries (LMICs). This paper addresses the lack of comprehensive research on mobility patterns for LMICs by examining the travel patterns of students, staff, and lecturers at the National Advanced School of Public Works, Yaoundé (NASPW) to understand transport mode choices and barriers to the use of public and active transport modes. Data was collected through online questionnaires from 425 participants. Findings revealed that most students (27.5%) used multiple modes of transport, with moto-taxis being the most common (21%). Lecturers primarily used private cars (50%), while staff relied on taxis or multiple modes (33%). Accessibility, vehicle speed, and flexibility appeared as the most important reasons for the preferred modes of transport. Barriers included long waiting times and traffic congestion for public transport, and distance and inadequate infrastructure for active mobility. The usage of public transportation was encouraged by its affordability and reduced travel time, whilst active options were preferred due to their cost savings and health benefits. To promote sustainable mobility for campus travel, it is crucial to encourage active modes, develop mass transport systems, and raise awareness through symposiums and conferences among students and staff.

Keywords: mobility; travel choices; active modes; public transport; low- and middle-income countries

1. Introduction

The concentration of population in cities is the cause of several health and environmental problems. One of the main problems is linked to the intensive use of private cars to travel short distances [1]. Environmentally, around 40% of carbon dioxide (CO_2) and up to 70% of other pollutants are linked to the intensive use of cars [2].

Sustainable urban mobility gathers all the means of transport that have the lowest negative effects on the environment. It implies planning the development of mobility of cities considering sustainability goals, thus rendering trips safer. Public transport and active mobility are key constituents of sustainable mobility.

A large number of trips are generated to access different facilities and amenities, such as shops, offices, leisure, public services, including universities. Universities around the world are increasingly concerned with creating more sustainable environments for students and adopting measures to encourage people to travel by active modes and public transport [3]. Meanwhile, Hopkins D. believes that the mobility of young adults is still understudied [4], especially in low- and middle-income countries. Moreover, the choice of transport mode is an individual, rational and complex decision

process, and in the specific case of mobility to campus, involving several criteria including, among others, distance, travel time, cost of travel, weather conditions and of course individual preferences. For this, it is therefore essential to understand individual behaviour in terms of travel and modal choice to promote the development of effective planning and management policies.

In general, the mobility patterns of students commuting to universities are often not thoroughly studied. While there is some research on this topic for High-Income Countries (HICs) [3,5–8] it remains under-researched for Low- and Middle-Income Countries (LMICs), with only a few studies identified [9,10]. The most recent research, which covered 28 LMICs, focused on adolescent active travel to schools but did not explore public transport or the barriers and factors affecting sustainable transport [10]. However, an interesting finding from this study is the high level of heterogeneity among LMICs, which underscores the need for context-specific research in LMICs. Additionally, it is important to note that the findings from HIC studies are likely not directly transferable to the context of LMICs, highlighting the necessity for further research that is tailored to LMIC. For example, studies show that most university students in HICs commute to school by public transport and active modes like cycling [5,7,11]. However, knowledge on this may not be relevant for some LMICs (like Cameroon) where public transport infrastructures and cycling lanes are nearly non-existent.

This knowledge gap leaves LMICs without the necessary information to support the adoption of effective planning and management policies. To bridge this gap, it is essential to understand the mobility patterns through research results collected from targeted societal groups like universities.

Therefore, this research aims to investigate the mobility patterns of students and staff at the National Advanced School of Public Works in Yaoundé (NASPW) as a case study. The objectives are to understand their mode choices, identify barriers to adopting public transport and active modes, and explore factors that could facilitate their adoption.

This study is highly significant for the university administration, city planners and urban municipalities in Yaoundé, as it provides useful information on travel patterns and barriers to sustainable transport modes. It also contributes to the limited body of research that exists in Cameroon and similar contexts on this topic.

2. Materials and Methods

2.1. Questionnaire Design

This work consisted of collecting data and analysing it to identify trends and determine the relationships between various mobility pattern-based parameters. The tool which made it possible to collect data on the mobility pattern of the student community as well as that of the teaching and non-teaching staff of the NASPW was an online questionnaire that was complemented by in-person survey. The Survey Monkey web platform (https://fr.surveymonkey.com/r/8DV5FWQ) was used for this purpose – it is a commonly used platform to implement mobility-related questionnaires [3,12,13].

The questionnaire was developed in advance and tested with a sample of students to ensure clarity, and any inconsistencies or errors were corrected. The final questionnaire, which was based on several styles, consisted of 30 questions organized into five section. The first section (question 1 to 14) included general questions on gender, age, place of residence, average income, campus attendance, and status in the university (student, teacher/researcher or staff member) among other information. The second part (questions 15 to 22) focused on the characteristics of home-to-campus and campus-to-home travel, the use of existing modes of transport, and the predominant modes of transport. Nine options were offered for the choice of modes of transport: private car, private motorcycle, bus, mini-bus, taxi, carpooling, cycling, walking, carpooling services such as Yango and ONGO.

Questions 23 and 24, forming the third section, inquired about the reasons behind participants' choice of their most frequently used mode of transport, considering factors such as cost, flexibility, accessibility, and comfort. The final two sections invited participants to discuss their openness to change transportation modes and to evaluate the challenges/barriers associated with using active travel modes and public transportation, as well as the incentives that could promote the adoption of these modes.

For questions with the variables to be assessed, the relative relevance of each variable was determined using a five-point Likert scale. For example, in question 15 concerning the evaluation of the use of transport modes, the levels were 1) not used; 2) little used; 3) moderately used; 4) used and 5) widely used. Details on the design for each question can be assessed from https://fr.surveymonkey.com/r/8DV5FWQ.

2.2. Sample Size Determination

A sample size testing was performed to estimate and determine the representative sample proportion of the university at 95% confidence interval. This was done using Slovins formula that is suitable for this purpose [14]:

$$n = \frac{N}{1 + Ne^2} \qquad (1)$$

where:

N = the population size

n = the sample proportion

e = level of error

Considering an error of 0.05 (at 95 confidence interval), and an estimated population (N) of NASPW at 2000, the required sample proportion (n) can be computed as follows.

$$n = \frac{2000}{1 + 2000(0.05)^2}$$

$$n = 333.3$$

Hence, an estimated population proportion of 334 is needed. The data was collected from 425 individuals, which is greater than the estimated sample proportion obtained. However, after data cleaning, a reduced sample size of 376 was deemed suitable for analysis, which still maintains statistical representativeness of the university population.

2.2. Statistical Analysis

Separate analyses were carried out using Excel and the Statistical Package for Social Sciences (SPSS) Version 27.

Chi-square test for association was used to verify the association and relationship between demographic characteristics (such as age and income level) and the barriers to public transport and active mobility. The Chi-square test for association is a statistical test used to determine if there is a significant association or relationship between two categorical variables. It compares the observed frequencies of each category with the expected frequencies that would be observed if there was no association between the variables. The hypothesis testing was as follows:

The null hypothesis was H0: There is no association between age and barriers to public transport.

The alternative hypothesis was H1: There is association between age and barriers to public transport.

P-value < 0.05 is in favour of H0, otherwise there is association. These hypotheses were also set for barriers to active mobility and also for the demographic characteristics income level.

The formula for calculating the Chi-Square statistics is:

$$x_c^2 = \frac{\sum(O_i - E_i)^2}{E_i} \qquad (2)$$

where:

c = degree of freedom

O = Observed Value

E = Expected Value

The Mann-Whitney was also performed which is useful to assess difference between results obtained from two independent variables. Also known as the U test, the Mann-Whitney is a non-parametric test that compares the medians of two populations that are not normally distributed.

An underlying assumption for appropriate use of the U test is that both populations are continuous or ordinal, independent of each other and comes from an unbiased sample.

The test statistic for the Mann Whitney test is U, which is the smaller of U_1 and U_2, defined by the following equations:

$$U_1 = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1 \tag{3}$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2 + 1)}{2} - R_2 \tag{4}$$

where:

R1 and R2 are the sum of ranks for observations from samples 1 and 2, respectively n_1, n_2 are the sample size.

Null Hypothesis (H0): η1 = η2

Alternative Hypothesis (Ha): η1 ≠ η2

η1 and η2 are the medians of the populations.

In the U test, the null hypothesis is rejected when the p value (significance) is lower than 0.05 indicating that there was a significant difference in the evaluation made [15].

This test was used to assess if there is a significant difference the perception of barriers to active mobility and public transport between males and females.

3. Results

3.1. Descriptive Statistics of Sample

The survey yielded 376 valid responses after data cleaning, down from an initial dataset of 425. The final dataset consisted of 360 students, 4 teachers/researchers(lecturer), and 12 staff members. The sample was approximately 72% male and 28% female. The most representative age group among students was 20 to 25 years (64%), among staff it was 35 to 50 years (50%), and for lecturer, it was over 50 years (75%). Among the students, 64% were dependents (relying on their parents or guardians for income), 18% earned less than 50,000 FCFA (about 90 USD), and the remainder earned more than 50,000 FCFA. The majority of staff and teachers had incomes exceeding 50,000 FCFA. Regarding driver's licenses, only 27% of the total sample possessed one. Table 1 presents a detailed description of the sample characteristics.

Table 1. Descriptive statistics of sample.

	Features	Students (N=360)	Lecturer (N=4)	Staff (N=12)	Total (N=360)
Gender	Male	72.20%	100%	50%	71.80%
	Female	27.80%	0.0%	50%	28.20%
Age	<20	13.6%	0.0%	0.0%	13.0%
	20 to 25	63.9%	0.0%	8.3%	61.4%
	25 to 30	12.5%	25%	16.7%	12.8%
	30 to 35	4.7%	0.0%	16.7%	5.1%
	35 to 40	3.1%	0.0%	25.0%	3.7%
	40 to 50	2.2%	0.0%	25.0%	2.9%
	>50	0.0%	75%	8.3%	1.1%

	Dependents	63.6%	0.0%	0.0%	60.9
Income	≤ 50,000	18.3%	0.0%	25%	18.3
	> 50,000	18.1%	100.0%	75%	20.8
Drivers	No	74.40%	33.30%	66.70%	73.60%
license	Yes	25.60%	66.70%	33.30%	26.40%

3.1. Modes of Transport Used and Reasons for Mode Choice

Figure 1 illustrates the transportation modes used by the university community for commuting between home and campus, along with the respective percentages observed. According to the survey, buses, mini-buses, bicycles, private motorcycles, and carpooling services were scarcely used for these journeys, one reason being their limited availability. Conversely, private cars, moto-taxis, and taxis were the most commonly used modes of transport. Both students and staff showed a preference for using multiple modes of transportation (27%). However, moto-taxis were the most popular single mode among students (20%), taxi amongst staff (33.3%) while lecturers predominantly used their private cars. Buses and min-buses are not reported as they recorded 0% for all groups.
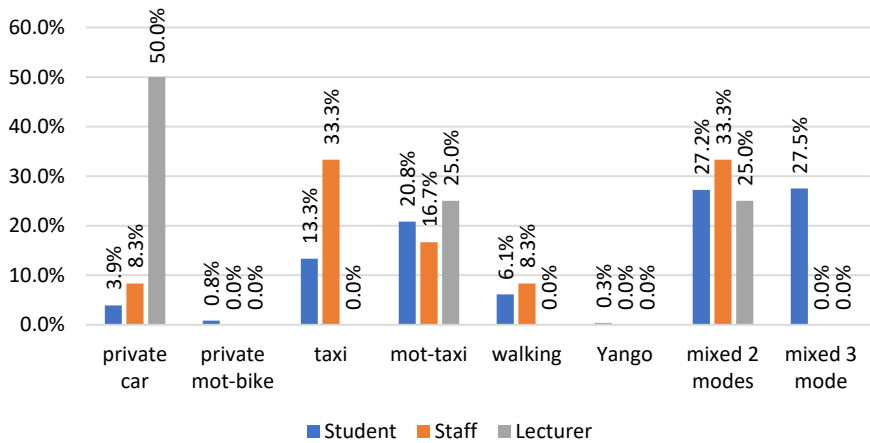

Figure 1. Modes of transport used.

Table 2 shows the results regarding the reasons for the mode choice, which was assessed using a five-point Likert scale. When comparing the weighted averages for the various reasons, the results indicate that accessibility, speed, and flexibility were among the top factors, while security and safety were lower on the list. These findings confirm the high usage of moto-taxis among students and private vehicles among lecturers, which are often easily accessible to them and provide a quicker means of arriving at school, in addition to offering greater flexibility.

Table 2. Reasons for using predominant modes.

Main Reason for Using the Predominant Modes	Weighted Average
Accessibility	3.94
It's fast	3.73
Flexibility	3.33
Cheap	3.16
No other choice	3.03
Proximity to campus	2.75
Security (low risk of harassment)	2.70

Safety (low risk of crashes)	2.50

Disaggregated analysis showed that for home to campus travel, the majority of the community (79.7%) travel directly from home to campus while the remaining (20.3%) first go to another destination before heading to campus. For campus to home travel, 40.1% leave campus for another destination before returning home, and 59.9% travel directly from campus to their homes.

Results show that 40.8% of students with an income of less than 50,000 FCFA prefer motorcycle taxis, as do 35.8% of those whose income is provided by their parents. Among those over 25 years old, motorcycle taxis are the most popular mode of transport, with 31.4% using them, followed by taxis at 27.1% and walking at 20.7%. This mobility behaviour reflects a preference for speed and availability within this age group.

Among male students, 34.19% prefer motorcycle taxis, followed by 27.2% for taxis and 23.3% for walking. Similarly, 38.4% of young female students favour motorcycle taxis, with 33.98% preferring taxis and 15.5% opting for walking.

3.2. The Desire to Change Modes of Transport

The community, comprising students, staff, and lecturers, was also asked about their willingness to adopt alternative modes of transportation. Overall, 80% of respondents expressed a willingness to change their current mode of transport. Specifically, 29.9% indicated a preference to switch to private cars for reasons of comfort and unrestricted mobility, while 18.3% were ready to opt for buses, as motivated by personal comfort and environmental protection. This is shown in Table 3 and Figure 2.

Table 3. Chosen modes if conditions were improved.

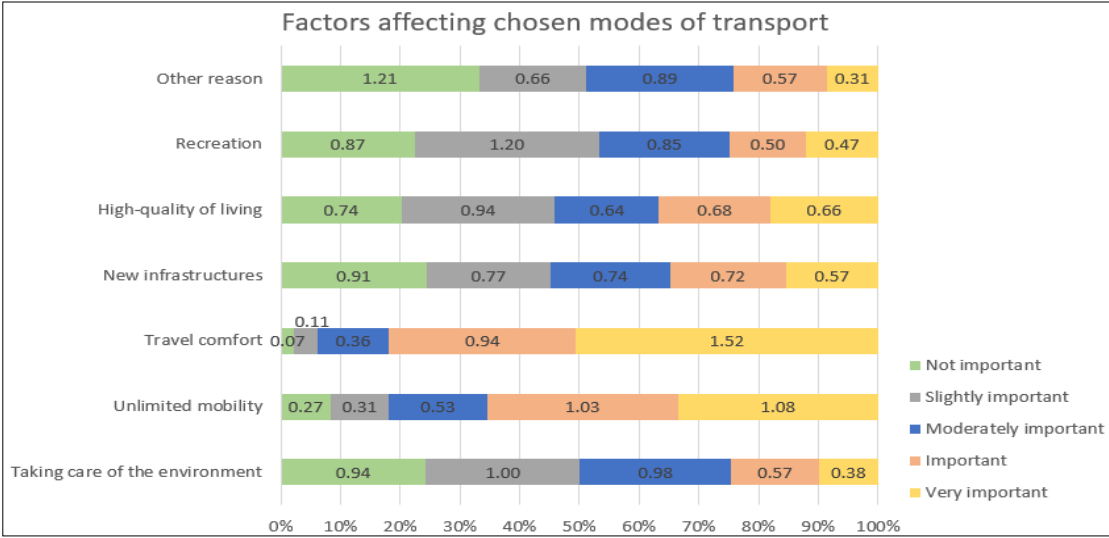| Choices	%
Private car	29.90%
Bus	18.30%
Private moto-Bike	11.10%
Mini-bus	9.40%
Carpool (transported by an acquaintance)	8.30%
Yango or On Go	7.00%
Taxi	6.60%
Walk (more than 300m on foot)	4.10%
Moto taxi	2.80%
Bicycle	2.60%

Figure 2. Factors affecting chosen modes.

3.3. Barriers to Use of Public Transport and Active Modes

As outlined in the methodology, participants were asked to evaluate various barriers (obstacles) to using public transportation and active travel methods using a five-point Likert scale. The findings regarding these impediments are summarized in Tables 4 and 5 for public transportation and active transportation modes, respectively.

In terms of public transport, the most significant barriers identified were long waiting time and traffic congestion. Travel duration and the inconvenience of stops being located far from participants' homes were also noted as considerable hindrances. Conversely, car ownership, weather conditions, and proximity to campus were deemed less significant obstacles.

When it comes to active modes of transportation, distance emerged as the primary barrier. The likelihood of choosing active transportation decreases as the distance between home and campus grows, with individuals tending to prefer motorized transport for longer distances. The second most critical factor is the absence of suitable infrastructure, which is intrinsically linked to road safety concerns as active travellers (pedestrian or cyclist) turn to face a higher risk of road crashes when there is no suitable infrastructure. Other notable barriers include adverse weather conditions, physical effort required, risk of theft, safety concerns, and mountainous terrain. However, the latter were not seen as a major deterrent to walking or cycling to campus, as these factors received lower ratings from the respondents.

Table 4. Barriers to use public transportation mode.

Variable	Weighted Average
Long waiting time	3.95
Traffic congestion	3.81
Travel time	3.72
No stops closer to the residence	3.52
Lack of adequate infrastructures	3.41
Car ownership	2.72
Weather conditions	2.65
Live near the campus	2.65

Table 5. Barriers to the use of active transportation modes.

Variable	Weighted Average
Distance	3.71
Lack of adequate infrastructures	3.52
Weather conditions	3.42
Physical efforts	3.38
Risks of theft	3.38
Lack of safety	3.28
Mountainous relief	3.2
Vehicle ownership	2.73

3.4. Results of Statistical Test

The Chi-Square test was conducted to assess the correlation between the following pairs of variables: age and barriers to public transport, level of income and barriers to public transport, age and barriers to active transport, and level of income and barriers to active transport. The results showed that in all cases, the p-values were greater than 0.05, indicating that the null hypothesis could not be rejected. Consequently, there is no statistically significant association between the pairs of variables tested.

The Mann-Whitney test was applied to determine if there were perceptual differences in barriers to active transport and public transport between females and males. The test results indicated no significant differences in the perception of barriers to active transport and public transport between the genders, as all p-values were above the 0.05 threshold, leading to the rejection of the null hypothesis in favour of the alternative hypothesis.

3.5. Factors in Favour of Public and Private Transport

The survey results, as detailed in Table 6, indicate that certain factors could encourage the use of public transportation. The most compelling of these factors include affordability, reduced travel times, and enhanced comfort and convenience. Specifically, the data analysis suggests that 19.8% of participants would be swayed by the affordability of public transport, 18.6% by the shorter travel times it offers, and 17% by its comfort and convenience.

Table 6. Factors in favour of public transport.

Variable	%
Affordable	19.80%
Low travel time	18.40%
Comfort and convenience	17.70%
Not owning a car or motorbike	15.30%
Adequate infrastructure	15.00%
Reducing environmental impact	13.80%

Likewise, Table 7 highlights factors that could promote the adoption of active transportation modes, with cost savings being the most influential. Other significant motivators for choosing active modes include health benefits, proximity to campus, environmental conservation, and the availability of sufficient facilities, listed in order of importance.

Table 7. Factors in favour of active modes.

Variable	%
Save money	23.20%
Health benefits	21.90%
Living near the campus	19.50%
Environmental protection	18.80%
Presence of suitable facilities	16.60%

4. Discussion

The survey reveals that travel between home and campus primarily involves the use of various modes of transportation, with motorcycle taxis being the favoured single mode among students, taxis among staff, and private vehicles among lecturers. This pattern differs significantly from that in High-Income Countries (HICs), where public transport is more commonly used by students, partly due to its greater availability [5,7,11]. This is also distinct from a case study in China, where the majority of students preferred walking or cycling, depending on the distance [9].

The factors of accessibility, speed, and flexibility were highlighted as the main reasons for the choice of the participants' current predominant mode of transport. The results also indicated that the pursuit of rapidity and accessibility was particularly common among young male students. The importance of accessibility and flexibility, which can be considered aspects of convenience, has been reported in other studies [3].

Overall, 80% of the respondents expressed a desire to change their mode of transport, with 29.9% showing interest in switching to private cars, primarily for comfort and unlimited mobility. However, this choice does not consider environmental sustainability, which contrasts with a study on mobility behaviour at the University of Tricity, where young people (Generation Y) were found to be environmentally conscious and preferred public transport and active modes [16]. Prevailing attitudes and stereotypes, such as "walking is for those who are not financially well-off" and "private vehicles are an indicator of wealth," are myths that urgently need to be dismantled.

In terms of barriers to public transport, long waiting times and traffic congestion were the most significant factors, which is consistent with past studies on barriers to using public transport for school commutes [11,17,18]. On the other hand, factors such as car ownership, weather conditions, and proximity to campus were rarely cited as impediments to public transport in previous research.

When it comes to active transport, such as walking and cycling, distance, lack of infrastructure, and weather conditions were identified as the most significant barriers. However, other factors like physical effort, theft, and safety concerns also received higher ratings, which is in line with previous research on the subject [3,19].

The Chi-square test results indicated no association between age or income level and barriers to public or active transport, suggesting that in a LMIC like Cameroon, mobility challenges affect the university community equally, regardless of income or age. This could be attributed to the generally low-income levels within the teaching community and the lack of policies to facilitate transport to and from campus.

The Mann-Whitney test results showed no difference in the perception of barriers towards active and public transport between females and males, indicating that both genders face similar mobility challenges and are not inclined towards specific barriers to active mobility and transport. Therefore, addressing these issues could improve mobility for both genders.

The following recommendations are suggested to improve the sustainability of travel for the university community:

- Improve pedestrian mobility: Carry out studies on pedestrian safety and walkability index, identify gaps and improve pedestrians' pathways.

- Improve cycling mobility: Create dedicated cycle paths connecting the university to areas with high student residence. Provide standards for safe cycling and ensure compliance. Create parking stations at the university and dedicated changing rooms for cyclists.
- Public transport: Establish mass transport. In the short term provide dedicated buses for students with frequent departures (especially at peak school hours) from specific locations around areas where several students reside. In the long term establish mass transport for the city within which students will benefit from.
- Raise awareness on active mobility and public transport: Organize conferences, workshops, and symposia on sustainable mobility to raise awareness and address specific issues related to this theme. Create a Sustainable Mobility Club tasked with raising awareness, promoting, and reflecting on efficient and environmentally friendly mobility. Introduce active mobility days to campus. Create dedicated portals for reporting issues and proposing solutions on active mobility.

5. Conclusions

The transition towards sustainable mobility is currently recognized as a significant socio-economic and environmental challenge. However, when it comes to understanding mobility patterns, particularly among young adults in low- and middle-income countries, there is a lack of comprehensive research. To fill this gap in knowledge, this paper examines the travel patterns of students, staff, and lecturers of the National Advanced School of Public Works in Yaoundé (NASPW) to understand transport mode choices and barriers to the use of public and active transport modes from home to campus and vice versa. To investigate this, online questionnaires were distributed via social media groups and on physical supports, yielding a total sample size of 376 valid responses. The collected data was analyzed to investigate the mobility patterns and the barriers and factors affecting sustainable mobility (active travel and public transport). Statistical tests were conducted to explore the association between demographic characteristics and the barriers to active travel and public transportation.

The study results showed that most students (27.5%) used multiple modes of transport, with moto-taxis being the most common (21%). Lecturers primarily used private cars (50%), while staff relied on taxis or multiple modes (33%). Accessibility, vehicle speed, and flexibility appeared as the most important reasons for the preferred modes of transport, while security and safety were of lesser concern. The key barriers to public transportation included long waiting times and traffic congestion, while distance, inadequate infrastructure, and weather conditions were barriers to active mobility. The factors that favored the use of public transportation included affordability and reduced travel time, while active options were preferred due to their cost savings and health benefits.

This research demonstrates that the choice of transport modes by students, staff, and lecturers depends on a variety of parameters that are specific to each group. The observed mobility pattern is unsustainable and requires interventions from the university and city councils to establish an efficient Sustainable Urban Mobility Plan (SUMP) that will improve home-to-campus and campus-to-home mobility. Future research on this topic may investigate the mobility patterns of students from different universities with differences in geographic areas and also consider a larger sample size. This research had some limitations, including the introduction of specific questions related to cycling paths and public transport, as these infrastructures are currently lacking. Once these become available, future research should investigate them.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data is available upon request.

Acknowledgments: We acknowledge the administrative staff and students at the National Advanced School of Publics.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Hooftman , N., Messagie , M., Van Mierlo, J., & Coosemans , T. (2018). A review of the European passenger car regulations – Real driving emissions vs local air quality. In *Renewable and Sustainable Energy Reviews* (Vol. 86, pp. 1–21). Elsevier Ltd. https://doi.org/10.1016/j.rser.2018.01.012
2. Nanaki, EA, Koroneos , CJ, Roset, J., Susca, T., Christensen, TH, De Gregorio Hurtado, S., Rybka, A., Kopitovic , J., Heidrich, O., & López-Jiménez, PA (2017). Environmental assessment of 9 European public bus transportation systems. *Sustainable Cities and Society* , *28* , 42–52. https://doi.org/10.1016/j.scs.2016.08.025
3. Ribeiro, P., Fonseca, F., & Meireles, T. (2020). Sustainable mobility patterns to university campuses: Evaluation and constraints. *Case Studies on Transport Policy* , *8* (2), 639–647. https://doi.org/10.1016/j.cstp.2020.02.005
4. Hopkins, D. (2017. Destabilizing automobility? The emerging mobilities of generation Y. *Ambio* , *46* (3), 371–383. https://doi.org/10.1007/s13280-016-0841-2
5. Sgarra , V., Meta, E., Saporito, MR, Persia, L., & Usami, DS (2022). Improving sustainable mobility in university campuses: the case study of Sapienza University. *Transportation Research Procedia* , *60* , 108–115. https://doi.org/10.1016/j.trpro.2021.12.015
6. Lundberg, B., Weber, J., 2014. Non-motorized transport and university populations: an analysis of connectivity and network perceptions. J. Transp. Geogr. 39, 165–178.
7. Fernandes, P., Sousa, C., Macedo, J., Coelho, M., 2019. How to evaluate the extent of mobility strategies in a university campus: an integrated analysis of impacts. Int. J. Sustainable Transp. https://doi.org/10.1080/15568318.2018.1531183
8. Moniruzzaman, M., Farber, S., 2018. What drives sustainable student travel? Mode choice determinants in the Greater Toronto Area. Int. J. Sustainable Transp. 12 (5), 367–379.
9. Zhan, G., Yan, X., Zhu, S., Wang, Y., 2016. Using hierarchical tree-based regression model to examine university student travel frequency and mode choice patterns in China.Transp. Policy 45, 55–65.
10. Felez-Nobrega, M., Werneck, A.O., Bauman, A. et al. Active school commuting in adolescents from 28 countries across Africa, the Americas, and Asia: a temporal trends study. Int J Behav Nutr Phys Act 20, 1 (2023). https://doi.org/10.1186/s12966-022-01404-y
11. Danaf, M., Abou-Zeid, M., Kaysi, I., 2014. Modeling travel choices of students at a private,urban university: insights and policy implications. Case Stud. Transp. Policy 2 (3), 142–152.
12. Lois, D., Monzón, A., & Hernández, S. (2018). Analysis of satisfaction factors at urban transport interchanges: Measuring travelers' attitudes to information, security and waiting. *Transport Policy* , *67* , 49–56. https://doi.org/10.1016/j.tranpol.2017.04.004
13. López- Lambas , ME, Monzón, A., & Pieren, G. (2017). Analysis of using electric car for urban mobility, perceived satisfaction among university users. *Transportation Research Procedia* , *27* , 524–530. https://doi.org/10.1016/j.trpro.2017.12.132
14. Jeffry J. Tejada and Joyce Raymond B. Punzalan(2012). On the Misuse of Slovin's Formula. The Philippine Statistician Vol. 61, No. 1 (2012), pp. 129-136
15. Soria-Lara, J., Marquet, O., Miralles-Guasch, C., 2017. The influence of location, socioeconomics, and behaviour on travel-demand by car in metropolitan university campuses. Transp. Res. D 53, 149–160.
16. Szmelter -Jarosz, A., & Suchanek, M. (2021). Mobility patterns of students: Evidence from Tricity area, Poland. *Applied Sciences (Switzerland)* , *11* (2), 1–17. https://doi.org/10.3390/app11020522
17. Nguyen-Phuoc, D., Amoh-Gyimah, R., Tran, A., Phan, C., 2018. Mode choice among university students to school in Danang, Vietnam. Travel Behav. Soc. 13, 1–10.
18. Zhou, J., 2016. Proactive sustainable university transportation: Marginal effects, intrinsicvalues, and university students' mode choice. Int. J. Sustainable Transp. 10 (9), 815–824.
19. Stein, P., Silva, A., 2018. Barriers, motivators and strategies for sustainable mobility at the USP campus in São Carlos, Brazil. Case Stud. Transp. Policy 6, 329–335.