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METU Students' Satisfaction with Transportation Within and to METU Campus

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Introduction

Middle East Technical University (METU) has one of the largest university campuses in Turkey. Unlike most of the university campuses in Turkey, every department is located within one campus. As such, travel within the campus is a crucial part of a student's university life. Students travel every day between a myriad of locations. This daily travel can affect student's everyday lives and mental states since they require careful time management. Because of this, travel within and to-and-from the METU campus influences many key aspects of a student's life, from stress management to their overall satisfaction with the campus life. The motivation behind this research stems from our direct experiences with travel problems confronted daily as students. Studies show that students' transportation choices are influenced by factors such as time pressure, cost, reliability, and safety [8, 5]. On large university campuses like METU, unreliable travel methods cause stress in students and make planning difficult. Travel problems can also act as a barrier to education by reducing students' ability to attend classes regularly or manage their time effectively [7]. In addition, students may not use their preferred travel method due to factors such as personal finance or accessibility. [3] Transportation experiences also differ depending on students' living locations. These differences can lead to frustration and uncertainty, particularly when bus schedules are unreliable [7]. Travel methods can also

Another important factor influencing transportation choices is time pressure related to how many years students have spent at the university. In their early academic years, students often have more flexible curricula. As a result, they may feel less pressure to rush between locations and are more tolerant of waiting for ring buses. However, as students approach their senior years, they tend to take on greater academic and personal responsibilities. Under increased time pressure, students often lose trust in slow or unpredictable public transportation systems and shift toward private options such as taxis or personal vehicles [8]. This shift is primarily driven by concerns about reliability and time control rather than comfort alone.

Safety and reliability also play a significant role in students' mobility decisions. When ring buses are known to be unreliable, students may choose to walk even though it is more physically demanding and time-consuming. Walking is often adopted as a response to unreliable transportation systems [2].

In addition to these individual factors, the physical layout of the METU campus creates unequal transportation experiences for students. While some departments are located in central areas of the campus, others are situated farther away or on steep terrain. Students studying in these distant departments often need to depart earlier and plan their time more carefully, which can increase stress and reduce overall satisfaction with university life [6].

Data and Methodology

This section details the data collection process, the description of variables used in the study, and the statistical methods employed for analysis.

Data Collection

To better understand the transportation problems at METU, we conducted a survey targeting METU students. Our population is all METU students which is around 24000 student and ranging from undergraduate to master's level. Our was distributed via student WhatsApp groups, which are widely used for communication. The survey link was shared in several groups, which will not be shared for privacy reasons.

There were a total of 3941 students throughout the WhatsApp groups our survey was shared. It must be noted that 3941 may not reflect the total number of unique students, as many students are likely to be in many different groups the survey was shared. We obtained 237 valid responses, which corresponds to a 6.01% response rate. This method of distributing the survey was chosen because of its speed and access to different student demographics. Survey responds were anonymous, and no private information were collected. The data was terminated after analysis.

To assess whether the achieved sample size was sufficient for the study objectives, standard sample size planning for estimating a population proportion was considered under an assumed simple random sampling framework for planning purposes. For a target margin of error of $d = 0.05$ and an 80% confidence level, the required sample size was calculated using

$$n_0 = \frac{z_{\alpha/2}^2 \, p(1-p)}{d^2}, \tag{1}$$

where $z_{\alpha/2}$ is the standard normal critical value corresponding to the selected confidence level and p denotes the anticipated population proportion. In the absence of a reliable prior estimate for p, the conservative choice $p = 0.50$ was adopted, yielding the largest required sample size and ensuring adequate precision.

The target population consists of approximately 24,000 METU students. Given the large population size relative to the achieved sample, the finite population correction was considered to have a negligible effect for planning purposes. Under these assumptions, the planned minimum sample size was approximately $n = 164$ responses.

The realized sample size of $n = 237$ therefore exceeds the planned requirement and corresponds to a higher nominal confidence level of approximately 88–89% for the same margin of error (assuming the same conservative proportion). While such margin-of-error interpretations are formally tied to probability-sampling assumptions, the achieved sample size provides a satisfactory level of precision and supports the reliability of the study's findings within the stated methodological limitations.

Description of Variables

The following variables were collected and analyzed throughout the study:

Preferred language: In the language preference section, English was offered as an option for those whose native language is not Turkish. Among the preferred languages, Turkish accounts for %86.9 of the votes, while English accounts for %12.2.

Gender identity: To understand the correlation between gender preferences and other variables, individuals were asked about their gender identity. Three options were provided: "Male", "Female", and "Prefer Not To Say". The percentages are: Male %50.6, Female %43.9, Prefer Not To Say %5.5.

Department: Field of study of the participants. Major percentages: Statistics (%9.3), Petroleum and Natural Gas Engineering (%8.9), Molecular Biology and Genetics (%6.8), Sociology (%5.5), Mechanical Engineering (%4.6), Foreign Language Education (%4.2). Other departments constitute smaller portions of the sample.

Level of Education: Undergraduate education (%84.0), Preparatory education (%14.8), Graduate education (%1.3).

Education Period Spent at METU: How long people have been a part of METU. Mean=28.75 months, Median=36.0 months, IQR=24.0 months, Range=70.0 months.

Accommodation Type: Private Accommodations (%49.4), On-campus Dormitories (%40.1), Off-campus Dormitories (%10.5).

Dormitories Located on Campus: For those staying on campus: Western Dormitories (%50.5), Eastern Dormitories (%49.5).

Accommodations Located Off-Campus: Main locations include İşçi Blokları (%14.8), Eryaman (%14.1), Cebeci (%8.5), Keçiören (%6.3), Mamak (%5.6).

Campus Rings (Semester) Usage: Very Frequently (%32.1), Frequently (%28.3), Sometimes (%22.8), Rarely (%11.0), Never (%5.9).

Campus Rings Schedules: Opinions on schedule adherence. Strongly Agree (%7.2), Somewhat Agree (%49.8), Neutral (%14.8), Somewhat Disagree (%28.3).

Campus Rings Comfortable: Strongly Agree (%2.2), Somewhat Agree (%19.7), Neutral (%21.5), Somewhat Disagree (%40.4), Strongly Disagree (%16.1).

Campus Rings Frequent: Strongly Agree (%4.1), Somewhat Agree (%17.8), Neutral (%7.3), Somewhat Disagree (%36.1), Strongly Disagree (%34.7).

Campus Ring Traffic Rules: People's opinions on whether campus shuttle drivers obey traffic rules. Strongly Agree (%26.5), Somewhat Agree (%34.7), Neutral (%19.2), Somewhat Disagree (%13.2), Strongly Disagree (%6.4).

Campus Rings Arrive Times: People's opinions on whether the campus shuttle buses arrive at their stops on time. Strongly Agree (%2.3), Somewhat Agree (%32.0), Neutral (%26.0), Somewhat Disagree (%31.5), Strongly Disagree (%8.2).

Campus Ring Stops: People's opinions on whether the campus shuttle bus stops are conveniently located. Strongly Agree (%15.1), Somewhat Agree (%43.8), Neutral (%16.0), Somewhat Disagree (%16.9), Strongly Disagree (%8.2).

Campus Ring Routes: People's opinions on whether the campus shuttle routes are suitable for them. Strongly Agree (%1.4), Somewhat Agree (%37.4), Neutral (%18.7), Somewhat Disagree (%35.6), Strongly Disagree (%6.8).

Taxi Usage: Very Frequently (%1.3), Frequently (%1.3), Sometimes (%36.3), Rarely (%31.2), Never (%30.0).

Taxi Price: Strongly Agree (%0.0), Somewhat Agree (%0.6), Neutral (%9.0), Somewhat Disagree (%30.7), Strongly Disagree (%59.6).

Taxi Safety: People's opinions on taxi safety. Strongly Agree (%9.6), Somewhat Agree (%20.5), Neutral (%32.5), Somewhat Disagree (%15.7), Strongly Disagree (%21.7).

Taxi Service Satisfaction: People's opinions are based on their satisfaction with taxi services. Strongly Agree (%1.2), Somewhat Agree (%16.0), Neutral (%33.3), Somewhat Disagree (%29.6), Strongly Disagree (%19.8).

Hitchhiking (Enter/Leave Campus): Very Frequently (%11.0), Frequently (%17.7), Sometimes (%11.4), Rarely (%27.4), Never (%32.5).

Hitchhiking (In campus): Statements regarding how often individuals prefer hitchhiking inside the campus. Very Frequently (%1.7), Frequently (%16.9), Sometimes (%28.3), Rarely (%23.2), Never (%30.0).

Walking (In Campus): Very Frequently (%48.9), Frequently (%29.1), Sometimes (%17.7), Rarely (%4.2), Never (%0.0).

Walking Safety: Statements from individuals about whether they felt safe while hiking. Strongly Agree (%41.4), Somewhat Agree (%37.1), Neutral (%10.1), Somewhat Disagree (%7.2), Strongly Disagree (%4.2).

Own Personal Transportation: Car (%74.5), Bicycle (%21.3), Motorcycle (%4.3).

Vehicle Sticker: Statements by individuals regarding which vehicle tag they possess. Students Yellow (%54.3), Students Brown (%45.7).

Parking Space Adequacy: Strongly Agree (%25.7), Somewhat Disagree (%20.0), Strongly Disagree (%54.3).

Stop for Hitchhikers: Statements from vehicle owners about how often they stop for hitchhikers. Very Frequently (%11.4), Frequently (%37.1), Sometimes (%45.7), Rarely (%0.0), Never (%5.7).

Subway Usage: Very Frequently (%47.3), Frequently (%14.8), Sometimes (%23.2), Rarely (%12.7), Never (%2.1).

Subways Consistency: Statements from individuals regarding whether the subways arrived on time. Strongly Agree (%34.9), Somewhat Agree (%33.6), Neutral (%19.8), Somewhat Disagree (%7.8), Strongly Disagree (%3.9).

Choose Somewhat Disagree: This is a control question; the variable we're trying to determine is whether the person solving it is truly reading and understanding the problem, or if they're solving it randomly. Strongly Agree (%0.3), Somewhat Disagree (%97.7).

Subways Comfort: People's opinions on whether using the subway is comfortable or not. Strongly Agree (%10.1), Somewhat Agree (%34.2), Neutral (%24.1), Somewhat Disagree (%25.9), Strongly Disagree (%5.7).

Subway Safety: Statements from individuals regarding whether they feel safe while using the subway. Strongly Agree (%6.6), Somewhat Agree (%30.3), Neutral (%30.7), Somewhat Disagree (%19.7), Strongly Disagree (%12.7).

Subway to METU location: People's opinions about being able to easily reach their desired destination after getting off the subway. Strongly Agree (%4.7), Somewhat Agree (%25.9), Neutral (%13.8), Somewhat Disagree (%36.6), Strongly Disagree (%19.0).

METU Location to Subway: People's statements about accessing the metro from within the METU campus. Strongly Agree (%0.9), Somewhat Agree (%32.8), Neutral (%10.3), Somewhat Disagree (%38.8), Strongly Disagree (%17.2).

Bus Usage: Very Frequently (%22.8), Frequently (%17.3), Sometimes (%25.3), Rarely (%15.6), Never (%19.0).

Bus Consistency: Statements from individuals regarding whether the busses arrived on time. Strongly Agree (%6.3), Somewhat Agree (%44.3), Neutral (%27.1), Somewhat Disagree (%17.7), Strongly Disagree (%4.7).

Bus Safety: Statements from bus users about whether they feel safe or not. Strongly Agree (%8.9), Somewhat Agree (%40.5), Neutral (%24.7), Somewhat Disagree (%25.3), Strongly Disagree (%0.5).

Bus Comfort: Statements from bus users regarding the comfort of the bus. Strongly Agree (%3.6), Somewhat Agree (%12.0), Neutral (%25.5), Somewhat Disagree (%46.4), Strongly Disagree (%12.5).

Bus Frequent: Statements from individuals regarding the frequency of buses to and from campus. Strongly Agree (%2.6), Somewhat Agree (%24.0), Neutral (%22.9), Somewhat Disagree (%33.3), Strongly Disagree (%17.2).

Bus Stop: Statements from individuals regarding whether the number of bus stops on campus is sufficient. Strongly Agree (%7.8), Somewhat Agree (%30.2), Neutral (%16.7), Somewhat Disagree (%24.5), Strongly Disagree (%20.8).

Bus Stop Convenient: Statements from individuals regarding the appropriateness of the bus stop layout on campus. Strongly Agree (%15.7), Somewhat Agree (%37.0), Neutral (%9.9), Somewhat Disagree (%30.7), Strongly Disagree (%6.8).

Security Checks: People's opinions on whether security checks at the campus entrance are appropriate. Strongly Agree (%16.1), Somewhat Agree (%23.4), Neutral (%26.0), Somewhat Disagree (%17.7), Strongly Disagree (%16.7).

Time Planning Difficulty: Strongly Agree (%0.4), Somewhat Agree (%23.6), Neutral (%12.2), Somewhat Disagree (%39.2), Strongly Disagree (%24.5).

Transportation Conditions Satisfaction: Strongly Agree (%3.8), Somewhat Agree (%11.0), Neutral (%33.3), Somewhat Disagree (%40.1), Strongly Disagree (%11.8).

Data Analysis

How Do Students Actually Move?

3.1.1 Campus General

There are a number of ways a student may find their way in regards to METU, both moving within the campus and travelling to-and-from the campus.

Our first objective is to determine which travel options are the most preferred across the entire METU campus. To this end, we asked students to rank the available travel options based on their preferences.

In within-campus rankings, there are 5 options (Campus Rings, Hitchhiking, Personal Vehicle, Taxi Services, Walking) and in to-and-from campus rankings, there are 6 options (Buses, Subway, Hitchhiking, Personal Vehicle, Taxi Services, Walking). These questions yielded the following results:

Method	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6
Subway	123	46	43	8	17	0
Buses	43	95	29	34	24	12
Walking	17	46	39	56	43	36
Hitchhiking	19	27	53	72	40	26
Taxi Services	0	12	50	44	95	36
Personal Vehicle	35	11	23	23	18	127

Table 1 To-and-From Campus Preferences

Method	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Walking	138	91	1	7	0
Campus Rings	75	83	58	17	4
Hitchhiking	5	38	122	57	15
Taxi Services	0	0	28	128	81
Personal Vehicle	19	25	28	28	137

Table 2 Within-Campus Preferences

In order to get a more clear view of the data and see exactly which options are preferred more over the others, we graphed the proportions of travel methods in each preference level for each section.

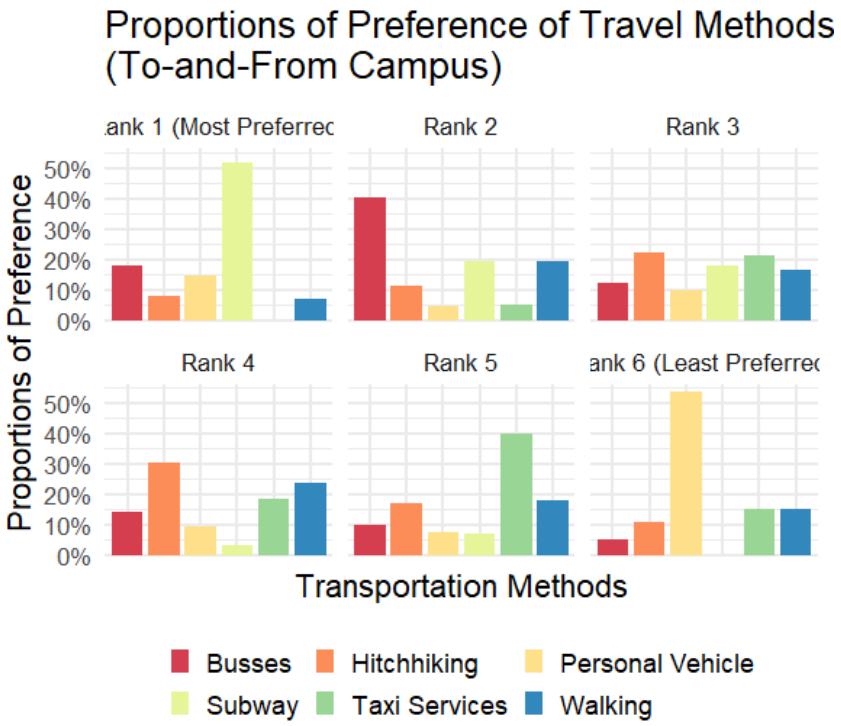

Figure 1

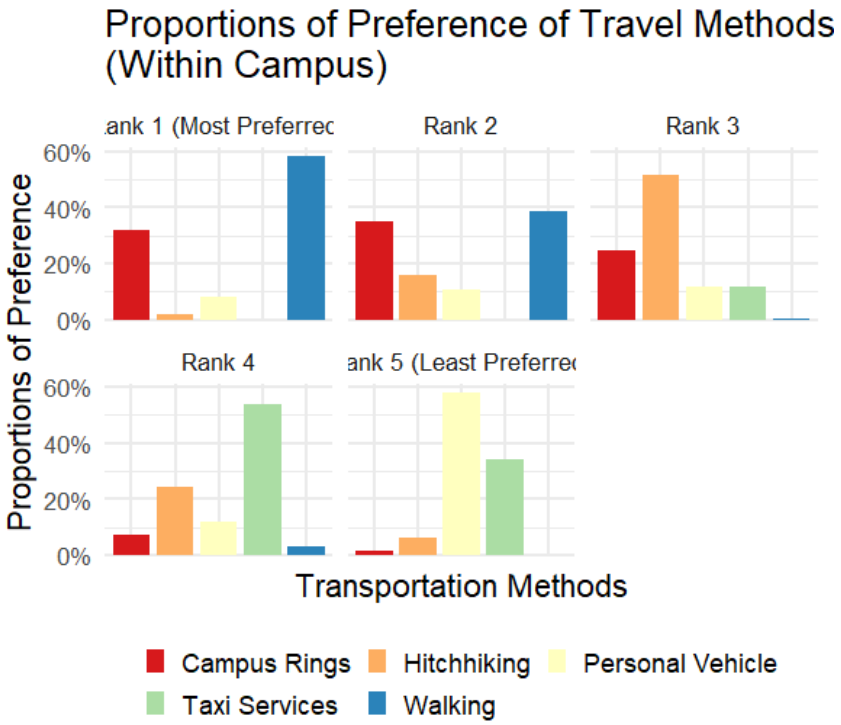

Figure 2

All 237 respondents provided complete rankings in both To-and-From and Within-Campus sections. The ranking variables are clean, so they can be treated as discrete random variables.

For each option j, let us define a random variable:
R_j = rank assigned to option j, (1 = most preferred, K = least preferred)
where $K = 5$ for within-campus and $K = 6$ for to-and-from campus

From this random variable, we can calculate the expected values and variance of each travel option's ranking.

For each transportation option j and respondent $i = 1, \ldots, 237$, we observe a rank $R_{ij} \in \{1, \ldots, K\}$. We can calculate the expected value of an option's rank by

$$\mathbb{E}[R_j] = \sum_{r=1}^{K} r \times p_j(r), \quad p_j(r) = P(R_j = r)$$

We can estimate the probability of a method j's ranking being r ($P(R_j = r)$) by using its frequency in our sample.

$$\hat{p}_j(r) = \frac{n_{jr}}{n}$$

where n_{jr} is the number of respondents giving option j a rank of r. This computation yielded in the following expected values of rank in each travel option:

Method	Mean Rank	Median Rank
Subway	1.95	1
Buses	2.73	2
Walking	3.72	4
Hitchhiking	3.70	4
Taxi Services	4.39	5
Personal Vehicle	4.51	6

Table 3 To-and-From Preference Means

Method	Mean Rank	Median Rank
Campus Rings	2.12	2
Walking	1.48	1
Hitchhiking	3.16	3
Taxi Services	4.22	4
Personal Vehicle	4.51	5

Table 4 Within Preference Means

Since these are ordinal variables, we choose median rank as the robust parameter.

These estimates tell us that when traveling within the METU campus, students' general preference order is as follows (from most preferred to least preferred): Walking, Campus Rings, Hitchhiking, Taxi Services, Personal Vehicle.

When traveling to-and-from the METU campus, students' preferences go as follows: Subway, Buses, Walking/Hitchhiking, Taxi Services, Personal Vehicle. In general, walking and hitchhiking are chosen as preferences 3 and 4 without a statistically significant difference between the specific ranking (a Wilcoxon Signed-Rank test yielded a p-value of 0.7 at the 5% level, confirming that no statistically significant difference exists between these two travel methods.).

To figure out if students generally disagree on the placements of these travel methods, we check the variance of each travel method.

$$Var(R_j) \approx \frac{1}{n-1} \times \sum_{i=1}^{n} (R_{ij} - \bar{R}_j)^2$$

The variances of each travel method are:

Method	Variance Rank
Campus Rings	0.989
Walking	0.437
Hitchhiking	0.714
Taxi Services	0.412
Personal Vehicle	1.85

Table 5 Within Preference Variance

Method	Variance Rank
Subway	1.48
Buses	2.07
Walking	2.31
Hitchhiking	1.92
Taxi Services	1.27
Personal Vehicle	3.58

Table 6 To-and-From Preference Variance

These tables show us that in both sections the method Personal Vehicle has a higher variance compared to other methods. This can stem from the fact that an individual who owns a personal vehicle (or has access to one via a friend or a colleague) could be more likely to use it more than other methods (most preferred) and those who do not have access to such a vehicle would, naturally, never use it (least preferred). This can cause a disagreement in the placement of Personal Vehicle in the rankings, and results in a higher variance.

Compared to within-campus answers, to-and-from campus answers have a higher variance in general for most methods. This can be attributed to students arriving from many different parts of Ankara. Some parts of the region do not have subway stations, so buses are used. The variance of walking is relatively high compared to within-campus answers or other methods in its own section. This can be due to the fact that both Ankara as a city and the METU campus are substantial in size, and students who mainly use walking as a travel method to get to and from the METU campus would be living in residence areas geographically close to the campus.

3.1.2 Differences Between Campus Demographics

Gender Differences - Within-Campus

Walking is the clear first choice for both Female and Male respondents in within-campus section. However, it is more concentrated among males. (Male mean/median = 1.34/1 vs. Female mean/median = 1.75/2). Campus Rings is more competitive among females (Female mean/median = 1.81/1.5) than among males (Male = 2.35/2); this matches the rank-1 counts. Male within-campus Walking variance is low (0.225), while Male Personal Vehicle variance is high (2.30). This further supports our assumption that Personal Vehicles have a disagreement in the rankings. Female within-campus shows higher dispersion for both Rings and Personal Vehicle (both 1.10) than for Taxi (0.444).

Gender Differences - To-and-From Campus

Subway is the top option for both genders (Female mean/median = 2.01/1, Male = 1.89/1). The main contrast is that males place Personal Vehicle notably higher (Male mean/median = 3.91/4) than females (Female = 4.98/6), while females place Hitchhiking higher (Female = 3.12/3) than males (Male = 4.19/4). Variance again highlights a disagreement in Personal Vehicle, especially for males (Male 4.14 vs Female 2.75). For Walking and Hitchhiking interchangeability within gender, paired Wilcoxon sign tests do not detect a statistically significant difference at the 5% level (Female $p = 0.305$, Male p=0.320).

Accommodation Differences

Subway is the most preferred in all three groups, but it is especially dominant in Off-Campus Dormitories (mean/median = 1.55/1, with rank-1 count of 25 over 29). Buses are relatively better among On-Campus Dorm respondents (mean/median = 2.24/2) than among Private Accommodations (mean/median = 3.05/3). The strongest subgroup-specific result is Walking vs Hitchhiking: Off-Campus Dorms show a statistically significant paired difference (Wilcoxon $p = 1.4 \times 10^{-5}$), with Hitchhiking ranking more favorably than Walking, while On-Campus Dorm ($p = 0.553$) and Private Accommodations ($p = 0.0663$) do not show a difference at the 5% level. Across all accommodation types, Personal Vehicle remains the most varied (Off-Campus 3.05, On-Campus 2.73, Private 3.91), consistent with previous findings.

Planning and Reliability

3.2.1 A Day of a Student

Our goal with this question was to deduce students' ability to make a complete journey in the METU campus. We constructed a scenario where a student enters the campus using the subway, tries to make their way to their class from the subway station in the A1 gate, and departs the campus at the end of the day.

A "subway journey cohort" was defined as respondents who either reported using the subway to travel to-and-from campus at least *Sometimes* or ranked the subway among their top two to-and-from campus options. This cohort included $N = 205$ students. All Likert items were numbered as ordered categories from 1 to 5 (1 = *Strongly Disagree*, 2 = *Somewhat Disagree*, 3 = *Neutral*, 4 = *Somewhat Agree*, 5 = *Strongly Agree*), so higher values indicate more agreement with the statement.

Within this subway cohort, perceptions show a clear distinction between the reliability of the subway itself and the viability of the full end-to-end journey. The statement **"Subways arrive at campus consistently"** had a median response of **4**, corresponding to **Somewhat Agree**, indicating that students generally view the subway's arrival consistency as acceptable. However, both connectivity components of the journey were

rated negatively. The median response for **"It is easy for me to travel to my destination after getting off from the subway"** was **2 (Somewhat Disagree)**, and the median response for **"It is easy for me to get to the subway from inside the campus"** was also **2 (Somewhat Disagree)**. In other words, even among students who are more likely to use the subway answered that the primary difficulty was not the subway's consistency but rather the segments that connect the subway to the destination, and the destination to the subway.

This pattern is consistent with the journey-level outcomes. The median response to **"I have no trouble planning my time for transportation options"** was **2 (Somewhat Disagree)**, implying that students generally experience difficulty planning their transportation time. Likewise, the median response for overall satisfaction (**"I am satisfied with my transportation conditions regarding the METU campus"**) was **2 (Somewhat Disagree)**, indicating that overall satisfaction is low within this cohort. Taken together, these results suggest that the subway can be perceived as reliable in isolation while the overall commute remains challenging because the last-mile legs reduce predictability and convenience, which in turn aligns with time-planning difficulties and dissatisfaction.

To characterize the within-campus leg of the subway-based journey, within-campus "primary mode" was defined as the respondent's rank-1 option among walking, campus rings, taxi services, hitchhiking, and personal vehicle. Among the subway cohort, the most common within-campus primary mode was Walking (61.5%, 126/205), followed by Campus Rings (32.2%, 66/205), with Personal Vehicle much less common (6.3%, 13/205). This indicates that the dominant subway-based journey pattern is Subway → Walking → Destination for most respondents, while a sizable minority rely on Subway → Campus Ring → Destination. The stacked proportional bar chart of subway reliability by within-campus primary mode visualizes whether perceived subway consistency differs across these within-campus plans (e.g., whether ring-reliant versus walking-based planners differ in their reliability ratings). For precise reporting, conditional proportions of subway reliability categories within each within-campus primary mode can be extracted and summarized as percentages, and the association can be formally evaluated using a nonparametric comparison of the ordinal subway reliability outcome across within-campus mode groups.

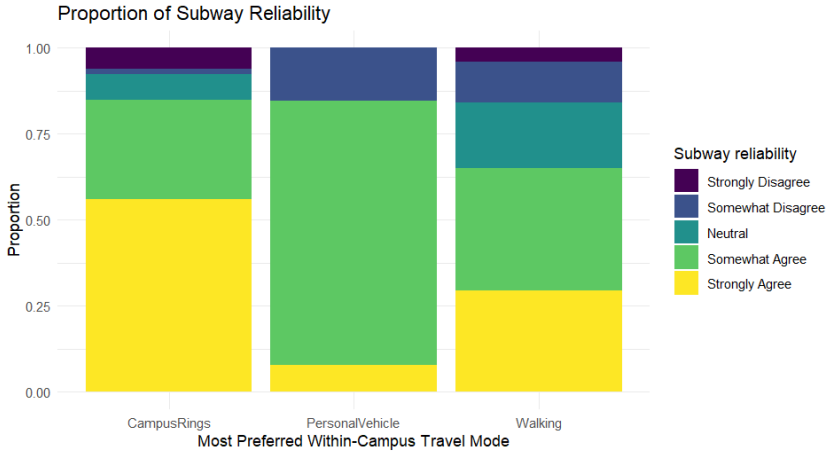

Figure 3

3.2.2 Departmental Reliability

To compare departments, we aggregated the overall satisfaction item (**"I am satisfied with my transportation conditions regarding the METU campus"**) at the department level using the **median** Likert score (1–5) as the primary summary (IQR shown for dispersion). Departments were then ranked from highest to lowest median satisfaction.

Based on this department-level satisfaction score, the top 5 most satisfied departments are as follows: Geological Engineering, Environmental Engineering, Political Science and Public Administration, Computer Engineering and Petroleum and Natural Gas Engineering

The top 5 most dissatisfied departments are as follows: Philosophy, Electrical and Electronics Engineering, Chemistry Education, Physical Education and Sports and Chemical Engineering.

These rankings may reflect several reasons including department buildings' position in the METU campus and the placement of Campus Ring stops.

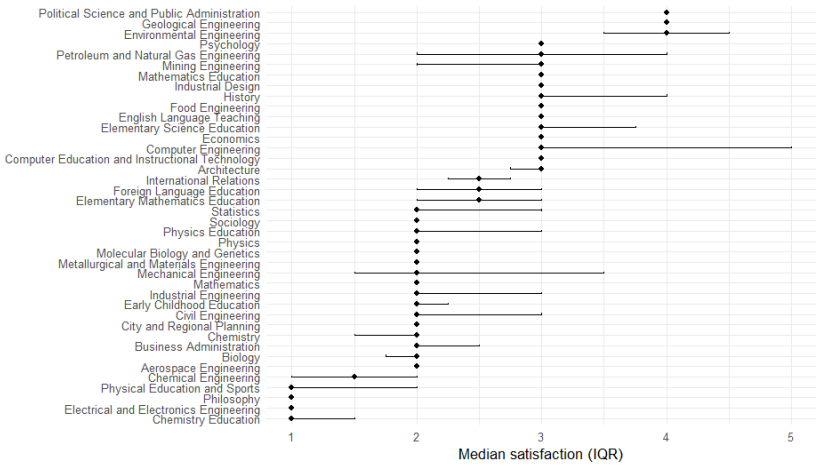

Figure 4

How Safe Do the Students Think Travel Options Are?

3.3.1 General Safety

Perception of safety is a substantial part of a student's travel habits. A method of travel may be consistent and reliable, but if it is not adequately safe, students will be discouraged from using it.

Many factors attribute to the perception of safety, such as a travel method's abidance to traffic rules, the demographic and the route of said travel method.

We asked respondents to answer their agreement levels with the following statements to determine their perception of safety in regards to travel options: *I feel safe using taxi services, I feel safe when walking inside the campus, I feel safe using the subway*, and *I feel safe using the bus*. The respondents answered as the following:

Item	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree
Bus	1	48	47	77	17
Subway	29	45	70	69	15
Taxi	36	26	54	34	16
Walk	19	20	11	134	53

However, campus rings are different. Campus rings' demographics reflect directly the student demographic. So, we thought that asking the students about general safety in regards to campus rings would reflect a student's opinions on the general student makeup of the campus rather than the safety of the travel method itself. Therefore, we asked the students their agreement with the statement *Campus ring drivers follow the traffic rules.* The proportions of their responses within ring usage are as follows:

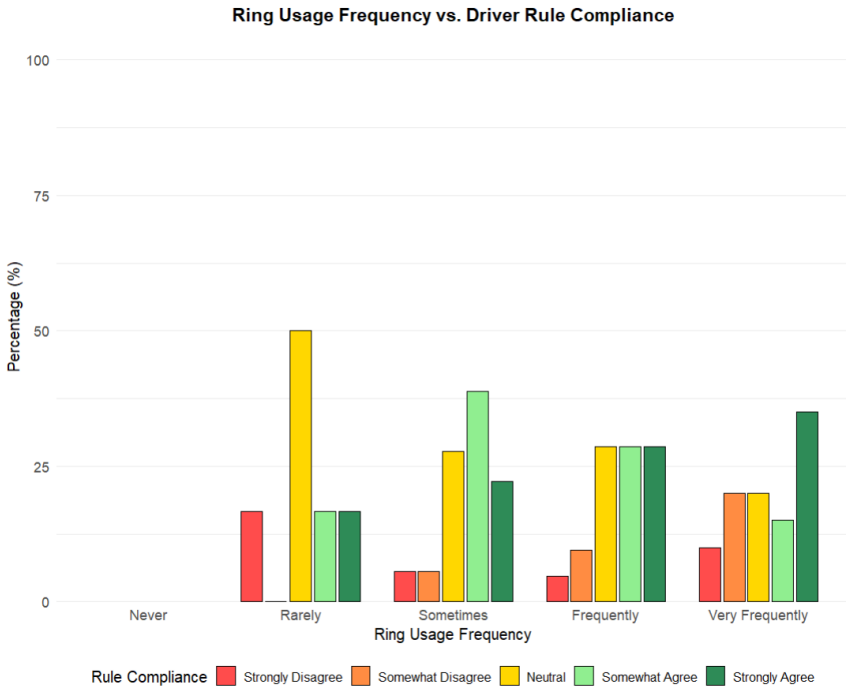

Figure 5

From these answers we can see that the students tend to think that the campus rings follow the traffic rules the more they use them. However, these answers could be biased. A student who considers campus rings to be unsafe would use it a lot less, and a student who uses the rings very frequently would think that they follow the traffic rules regardless if the rings actually abide by the rules or not. Due to these reasons, it is hard to make an unbiased and accurate statistical analysis on this data without access to a lot more information about the population.

To conduct tests on general safety, a safety score index to rank modes on a single numeric scale was constructed as: *Strongly Disagree = -2, Somewhat Disagree = -1, Neutral = 0, Somewhat Agree = 1, Strongly Agree = 2*

Item	Non-Missing	Mean	Standard Deviation	Median
Bus	190	0.321	0.969	0
Subway	228	-0.018	1.130	0
Taxi	166	-0.193	1.260	0
Walk	237	0.768	1.132	1

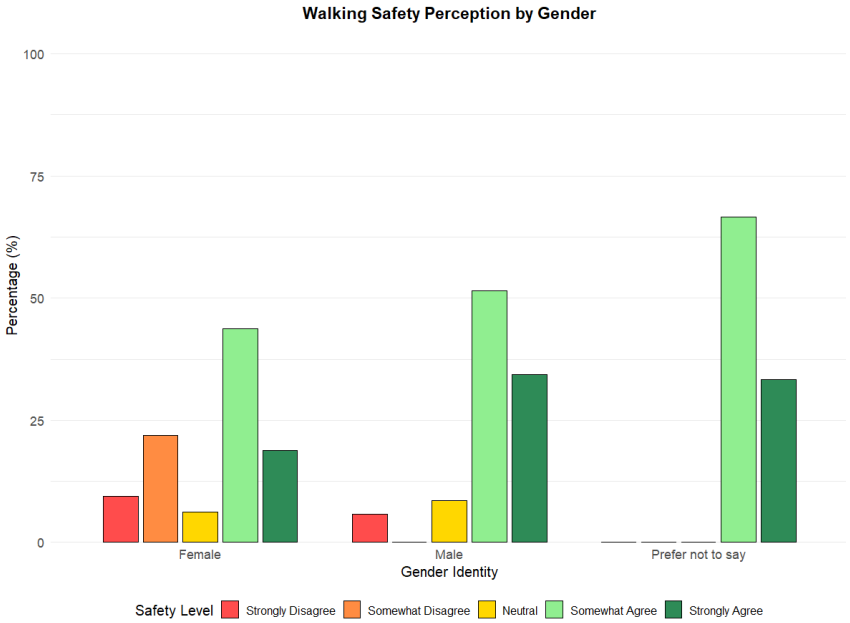

Figure 6

Across all four travel methods, Walking is perceived as the safest option. It has the highest mean safety score (0.768) and a median of 1 (*"Somewhat Agree"*).

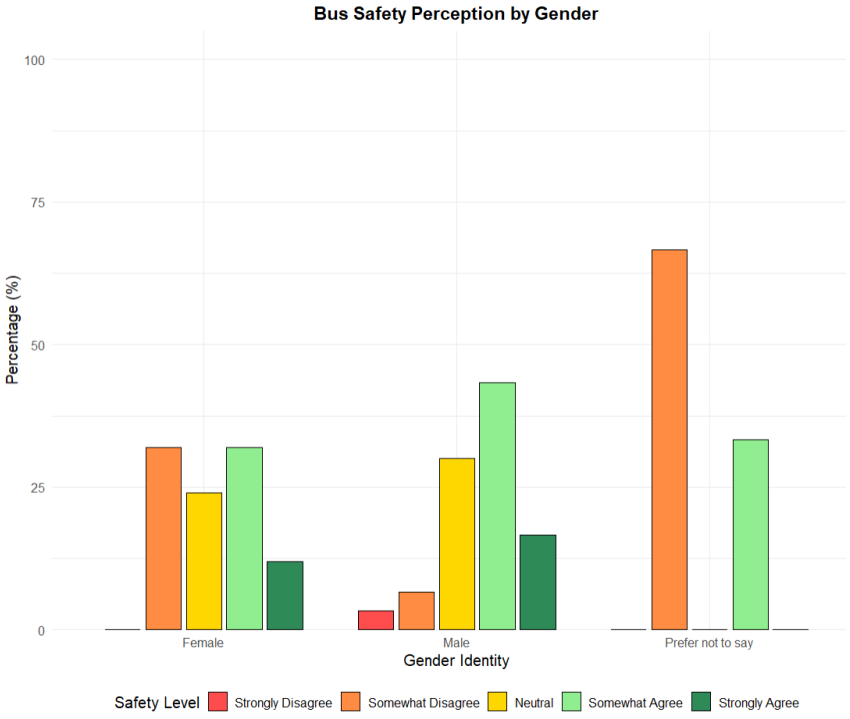

Figure 7

Buses are perceived as the safest after Walking ($Mean_{Buses} = 0.321$)

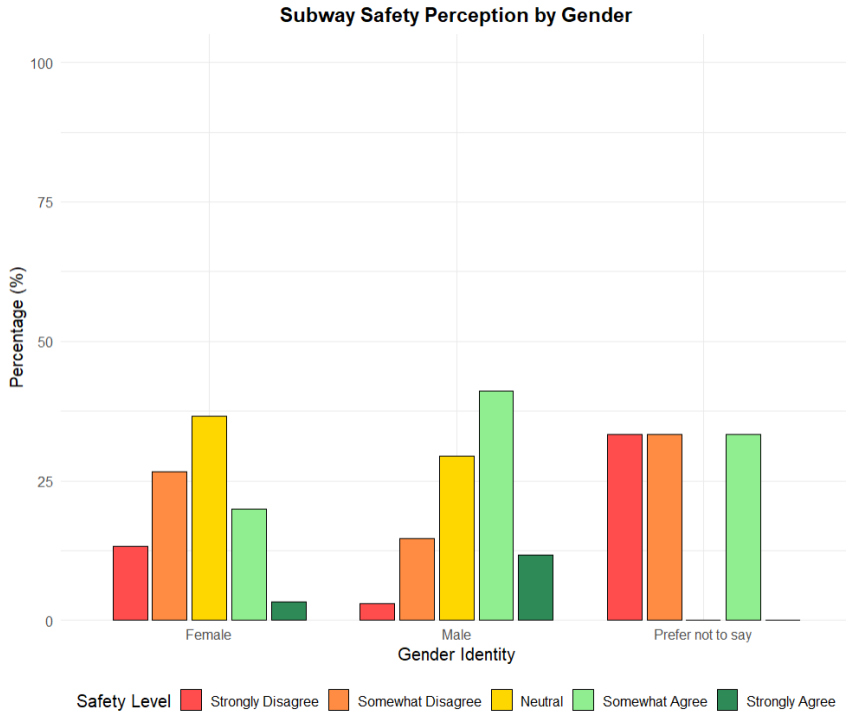

Figure 8

Subway is close to a neutral overall, with a mean of -0.018.

Figure 9

Taxi is perceived as the least safest with a mean of -0.193.

3.3.2 Gender-Based Safety Perceptions

An individual's safety varies greatly based on their gender. Safety concerns are especially important for female students. Female students tend to feel less safe at night or in poorly lit areas, which can restrict their mobility and lead them to modify their daily routines, such as leaving campus earlier than planned. [1, 4] Therefore, it is necessary to conduct a gender-based analysis of safety perceptions.

To compare safety perceptions between Male and Female respondents, two-sided Mann-Whitney U test was conducted. Respondents with the gender identity *Prefer Not to Say* were excluded from these tests due to a lack of sample size (n=13).

Item	n(Male)	n(Female)	U Statistic	*Holm* p-value
Bus	106	71	4839	0.0013
Subway	119	96	7572	0.000084
Taxi	77	81	2732	0.165
Walk	120	104	7858	0.00063

Table 7 Mann-Whitney U Test Results

For the Subway, Bus and Walking travel options, the Mann-Whitney U test shows statistically significant safety perceptions at the 5% level. However, taxi options show no statistically significant difference between genders. This may be due to the fact that neither gender considers taxi safe nor generally uses it.

In Subway and Walking, female students tend to feel slightly less than male students. However, in Bus travel method, female students tend to feel substantially less safety compared to male students.

In conclusion, female students feel less safe compared to male students, especially for Subway and Bus travel methods. On the other hand, taxi method does not show any difference between either gender.

How Does Time Spent in METU Affect Travel Habits?

3.4.1 Differences Between Academic Years

It is reasonable to think that a student's travel habits can change significantly as they spend more time travelling to and within METU, and get more acquainted with travel options available to them. In this section, we aim to explore the precise effects of a student's time spent in METU to their travel habits.

We measured time spent in METU in months, and grouped them into bins. The responses of 237 respondents are as follows:

Academic-Year Group	Number of Students
0-12	44
12-24	58
24-36	69
36-48	53
48+	13

Table 8 Number of Students in Academic-Year Bins

Because the 48+ group is so small (n=13), its boxplots and medians are more sensitive to a few respondents.

In order to properly analyse students' planning, satisfaction and safety opinions, we Likert-coded the following questions: *I have no trouble planning my time for transportation options.*, *I feel safe using taxi services.*, *I feel safe walking inside the campus.*, *I feel safe using the subway.*, *I feel safe walking inside the campus.*, *I am satisfied with my transportation conditions in relation to METU campus.*

For each transportation mode, the responses were recorded in two ways:

Scheme A: *Never = -2, Rarely = -1, Sometimes = 0, Frequently = 1, Very Frequently = 2*

Scheme B: *Never = -4, Rarely = -1, Sometimes = 0, Frequently = 1, Very Frequently = 4*

Each recorded frequency X is then standardized:

$$I = \frac{X - \bar{X}}{Var(X)}$$

In this scaling, 0 is sample-average user, positive is above-average and negative is below-average.

These values were computed for:

- **Within-Campus**: Campus Rings, Hitchhiking, Taxi, Walking
- **To-and-From Campus**: Bus, Subway, Hitchhiking, Taxi
- **Totals:** Mean of the available per-method indices. (Both within-campus and to-and-from campus averages 4 methods.)

To test whether there is a difference between academic year groups, the *Kruskal-Wallis Test* (with default *Holm-Bonferroni correction* to the p-values to counteract the problem of multiple comparisons) may be used.

The effect size for *Kruskal-Wallis* is reported as:

$$\epsilon^2 = \frac{H - k + 1}{n - k}$$

where a larger value means that the proportion of rank is more attributable to group membership.

We must note that this test was calculated in R using pre-built functions.

Furthermore, we check *Spearman's* ρ afterwards to see if there is a statistically significant *monotone* trend across the five bins.

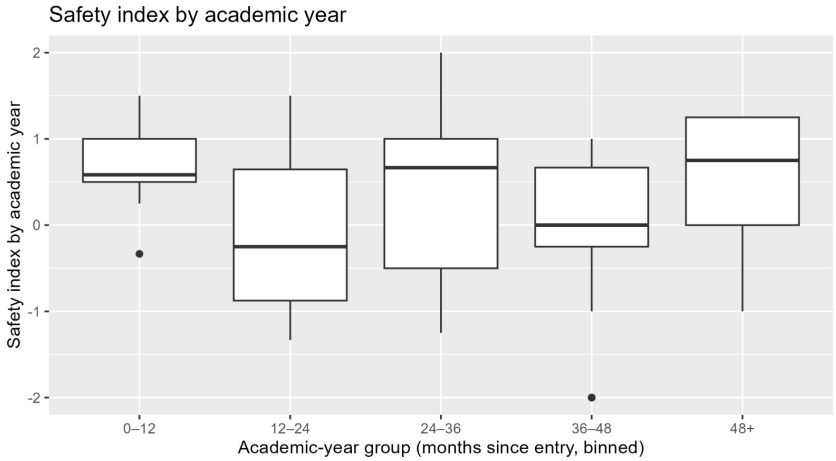

Figure 10

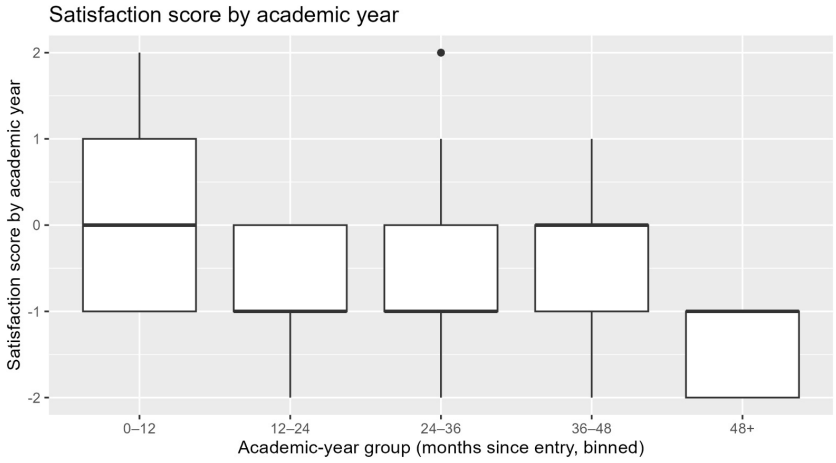

Figure 11

Score	H (df=4)	ϵ^2	p (Holm)
Planning	50.81	0.202	7.34e-10
Safety	27.10	0.1	1.89e-05
Satisfaction	39.03	0.151	1.37e-07

Table 9 *Kruskal-Wallis* Results

Score	ρ	p (Holm)
Planning	-0.043	0.511
Safety	-0.08	0.273
Satisfaction	-0.096	0.203

Table 10 *Spearman's* ρ Significance

From the *Kruskal-Wallis* and *Spearman's* ρ results, it can be seen that all Planning, Safety and Satisfaction scores differ by academic-year groups. However, none of the

adjusted p-values of *Spearman's* ρ are statistically significant at the 5% level. Overall, there is a statistically significant difference between the groups, but these trends are not monotone across all the bins.

3.4.2 Differences Between Schemas Constructed

The main reason behind creating two such schemas is to allocate more weight to extremities in scoring and conduct a sensitivity analysis on the effects of these extremes in the outcomes.

All methods (in both within and to-and-from) show statistically detectable differences across bins after *Holm-Bonferroni correction*.

After applying the schemas and running the tests again to within-campus and to-and-from campus sections, per travel method, both *Kruskal-Wallis* and *Spearman's* ρ results are identical across Schema A and Schema B.

However, in checking for totals (effect all travel options available isolated in within-campus and to-and-from campus sections) differ for Schemas A and B because totals average multiple transformed components. Total within-campus separates bins more strongly under Schema B, while total to-and-from campus separates more strongly under Schema A.

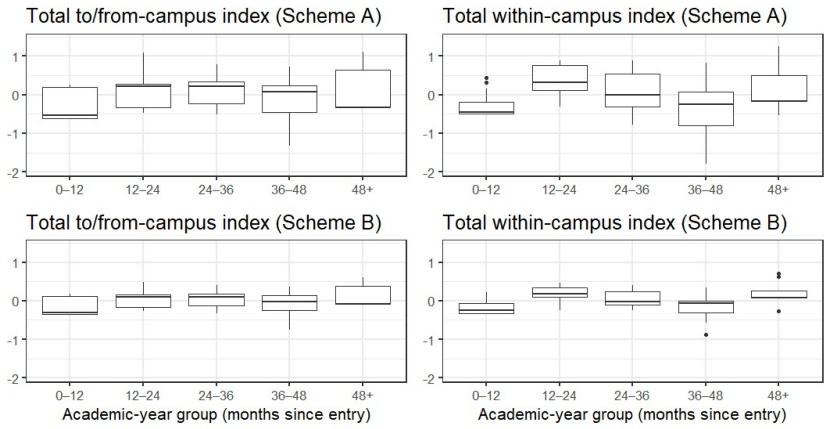

Figure 12

Both totals show *Holm*-significant *Kruskal-Wallis* for both Schema A and B totals. Neither total shows a *Holm*-supported monotone trend.

In conclusion, across academic-year groups, students' planning, safety and satisfaction differ substantially, but not in a strictly monotone way. Usage patterns show a clear change: Hitchhiking increases with academic-year group (in both within-campus and to-and-from campus sections). Walking decreases within-campus section, and subway decreases. Furthermore, several other methods show statistically significant group differences without a clear monotone trend.

Conclusion

References

[1] K. Clifton and Y. Wang. "Gender, safety, and walking behavior". In: *Transport Policy* (2020).

[2] Journal of Transport and Land Use. "Walking as a response to unreliable transport". In: (2024).

[3] MDPI. "Campus transportation mode choices". In: *Sustainability* (2023).

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