Group 1

Technical Report

Introduction:

This is a report regarding a survey conducted which asked students the following questions:

- What are your methods of travel to UTM on a regular basis?
- How far do you travel to get to UTM?

The population of the study is current STA304H5 students enrolled Fall 2019 term, whom were invited to participate. The sampling frame is the students within the population that have signed the consent form for participation in the survey.

Survey Statistics:

Population (τ): Current STA304H5 Students at UTM
Sampling Frame: Students taking STA304H5 in the Fall Semester whom have signed the consent form.
Population Size (N): 247
Sampling Size (n):
Goal: n >= 30 (so CLT applies)
Actual: n = 106

Response Rate: $\frac{106}{297} \times 100 = 42.91\%$

42.91% is a good response rate. Comparatively, UofT (a reputable institution with much larger resources) published a report titled “Results of the National Survey of Student Engagement 2017” in July 2018.

- They surveyed 9380 students and attained a response rate of 31%
- We have a greater response rate with both a smaller population and fewer resources

Objective:

Evaluate the potential relationships between distances from campus and students’ methods of transportation, respectively.

Hypothesis:

The distance a student lives from UTM affects their methods of transportation. We anticipate the closer a student lives the more likely they are to take public transportation. In turn, the further a student lives the more likely they are to drive independently or carpool. Consequently, the relationship between distance from campus and likelihood of using public transit is inversely proportional.

Distance (in km)	Public Transportation	Drive independently	Carpool	Non-Motorized	UTM Shuttle	Combination of Methods	TOTALS
10>	23	22	7	3	0	7	62
10-25	7	14	1	0	0	0	22
26-30	2	1	0	0	0	0	3
31-40	1	4	2	0	3	1	11
41-50	0	2	0	0	0	0	2
50<	1	2	0	0	1	0	4
TOTALS	34	45	10	3	4	8	104

Figure 1: Summary of Responses from Question 1 and Question 4

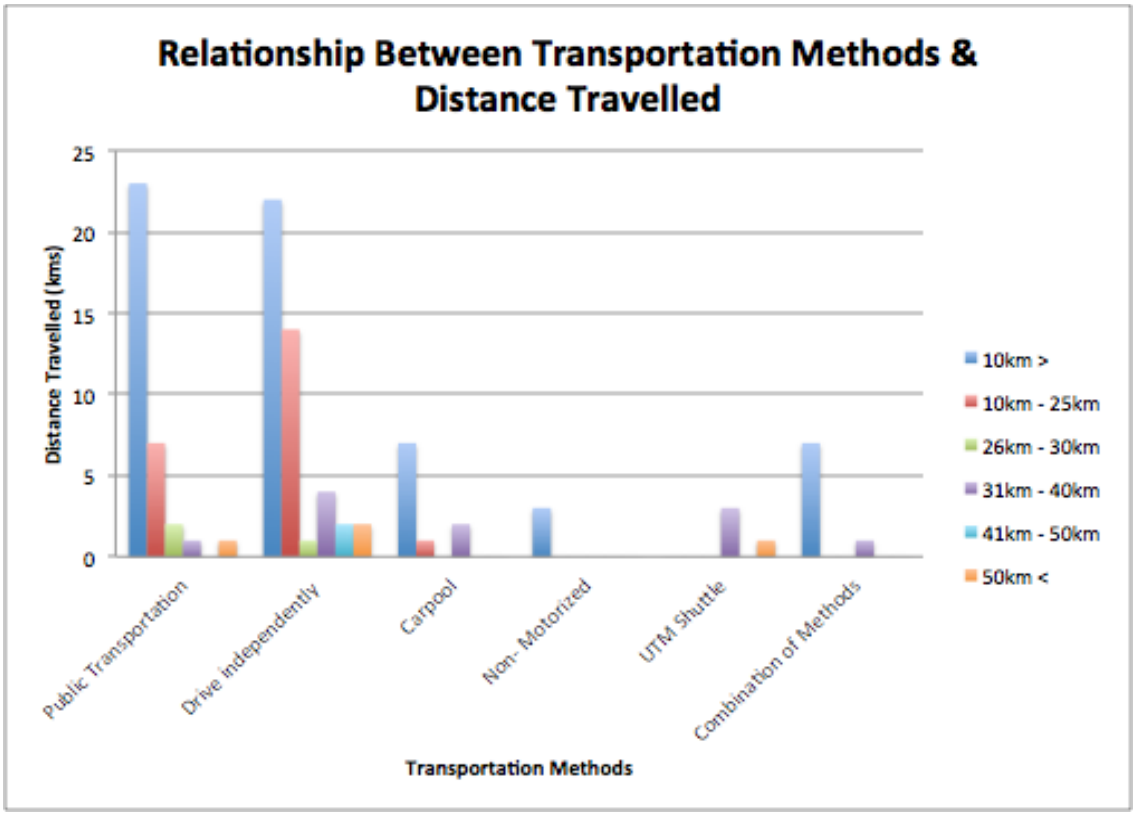

Figure 2: Relationship Between Transportation Methods and Distance Travelled

Distance (in km)	Public Transportation	Drive Independently	Carpool	Non-Motorized	UTM Shuttle	Combination of Methods	TOTALS
10>	0.37	0.35	0.11	0.048	0	0.11	≈ 1
10-25	0.31	0.64	0.05	0	0	0	≈ 1
26-30	0.667	0.333	0	0	0	0	≈ 1
31-40	0.09	0.367	0.189	0	0.27	0.09	≈ 1
41-50	0	1	0	0	0	0	≈ 1
50<	0.25	0.5	0	0	0.25	0	≈ 1

Figure 3: Conditional Probability Chart via Bayes Theorem

Each probability input represents P(A|B) calculated by Baye's theorem;

A = transportation method, B= distance

Since we are calculating the probability of a transportation method *given* a certain distance, the marginal totals of each row will be approximately 1. Likewise, if we calculated the probability of a distance *given* a specific transportation method, the marginal probabilities of each column would be approximately 1.

$$P(A_j|B) = \frac{P(A_j \cap B)}{P(B)} = \frac{P(B|A_j)P(A_j)}{\sum_{i=1}^{k} P(B|A_j) \cdot P(A_j)} \quad j = 1, \ldots, k$$

Figure 4: Bayes Theorem Formula

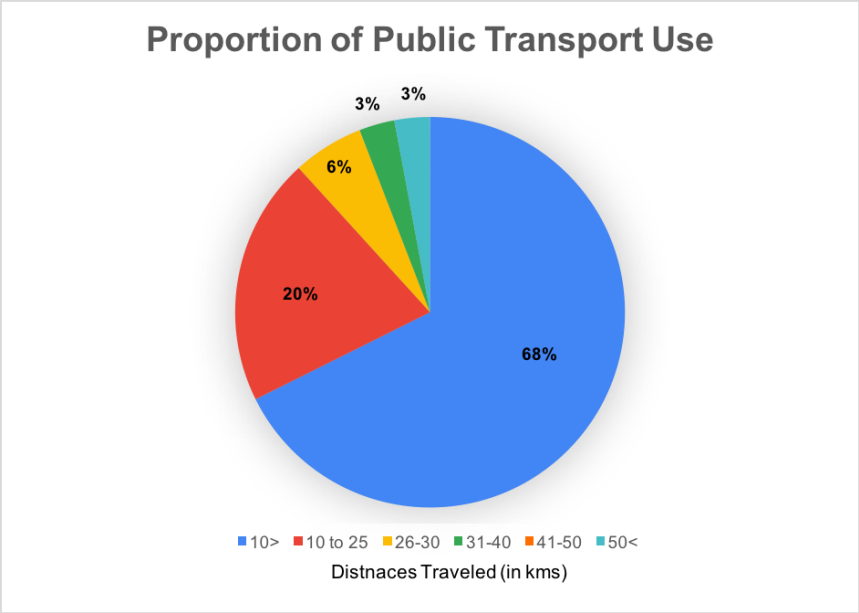

Figure 5: Proportion of Public Transport Use

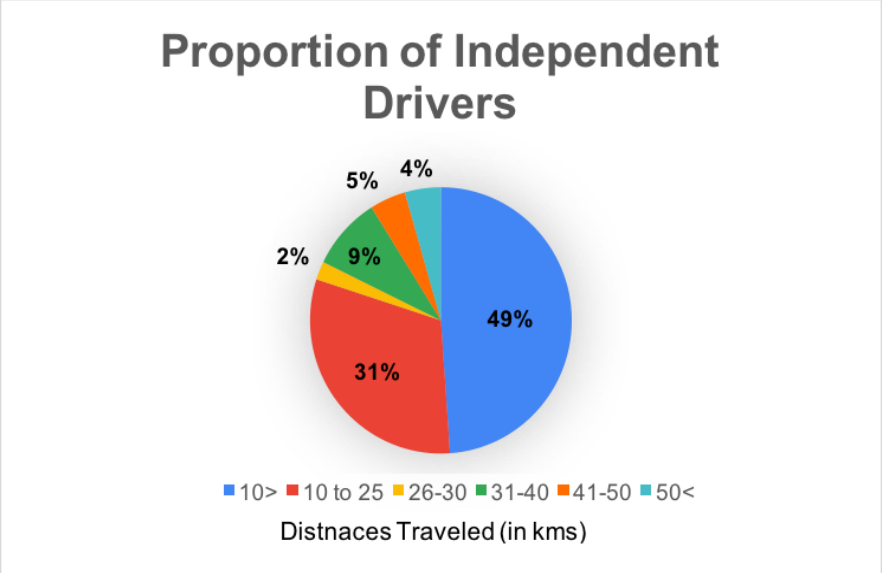

Figure 6: Proportion of Independent Drivers

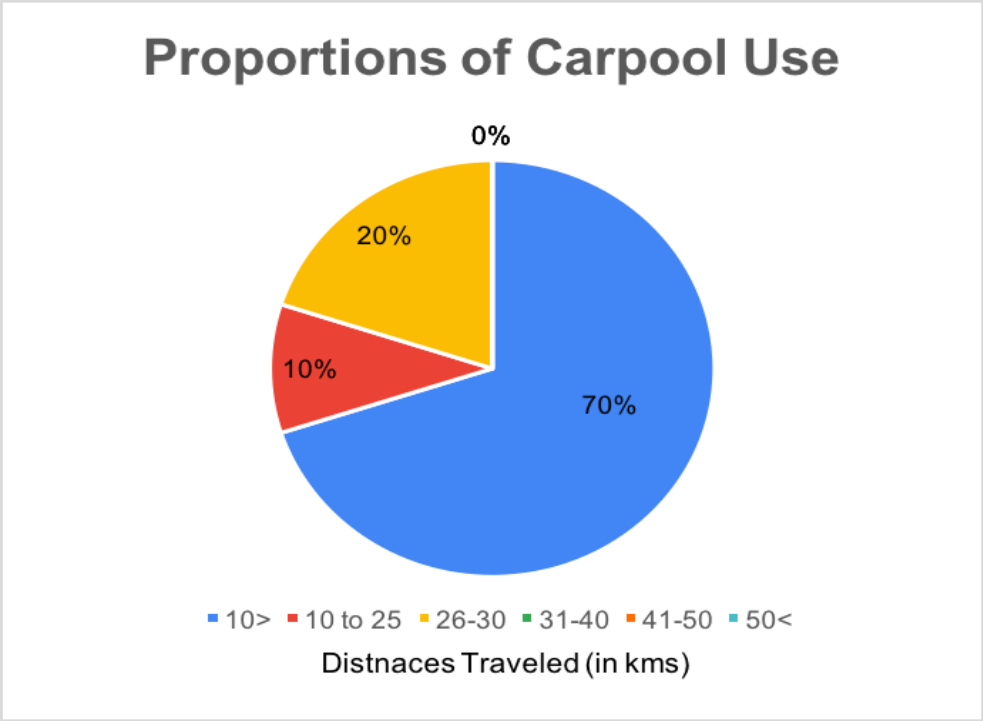

Figure 7: Proportions of Carpool Use

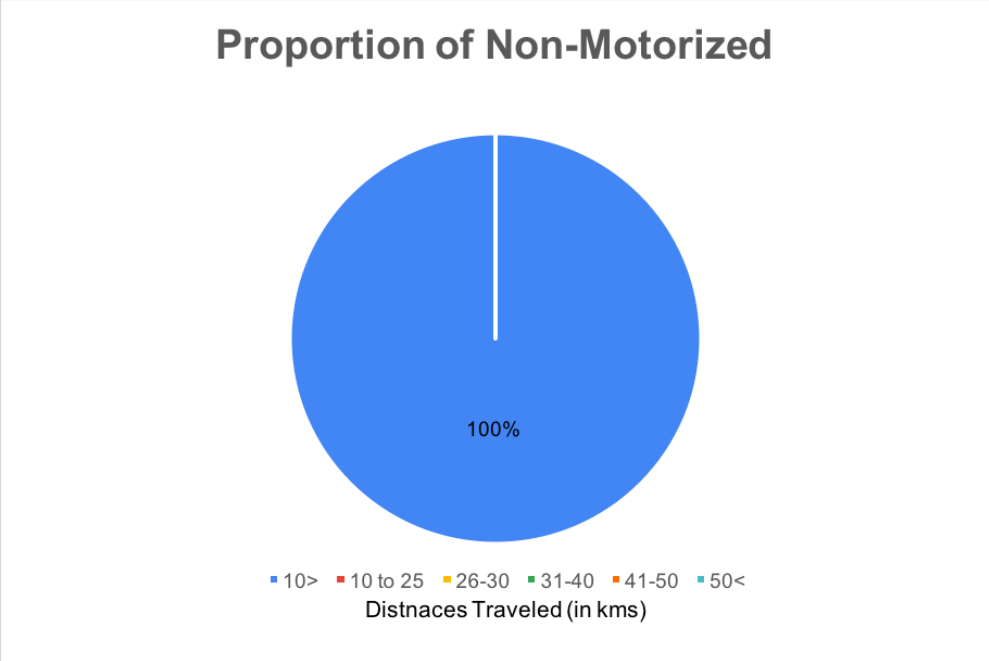

Figure 8: Proportion of Non-Motorized Users

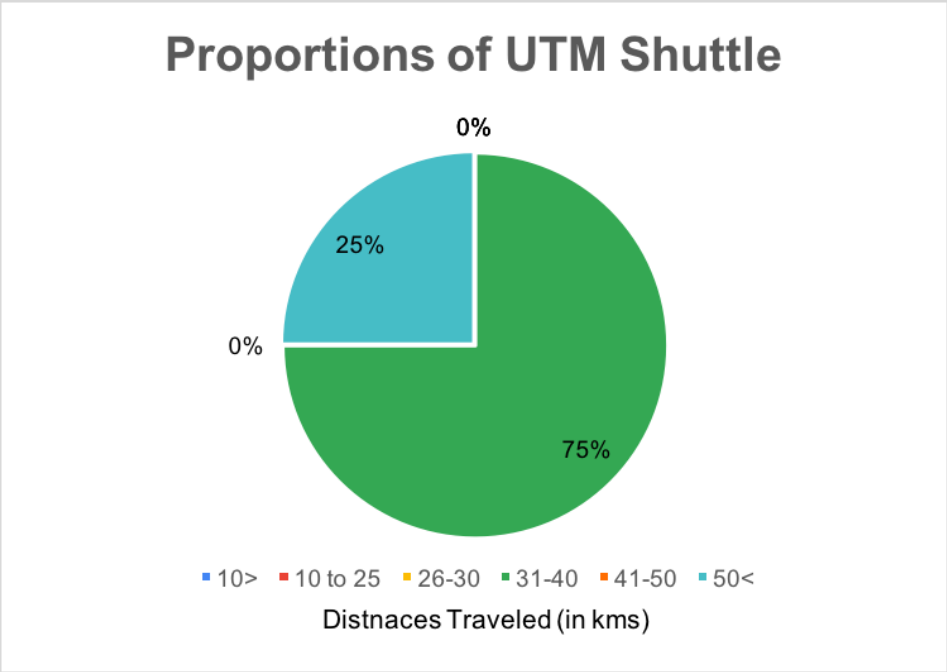

Figure 9: Proportion of UTM Shuttle Users

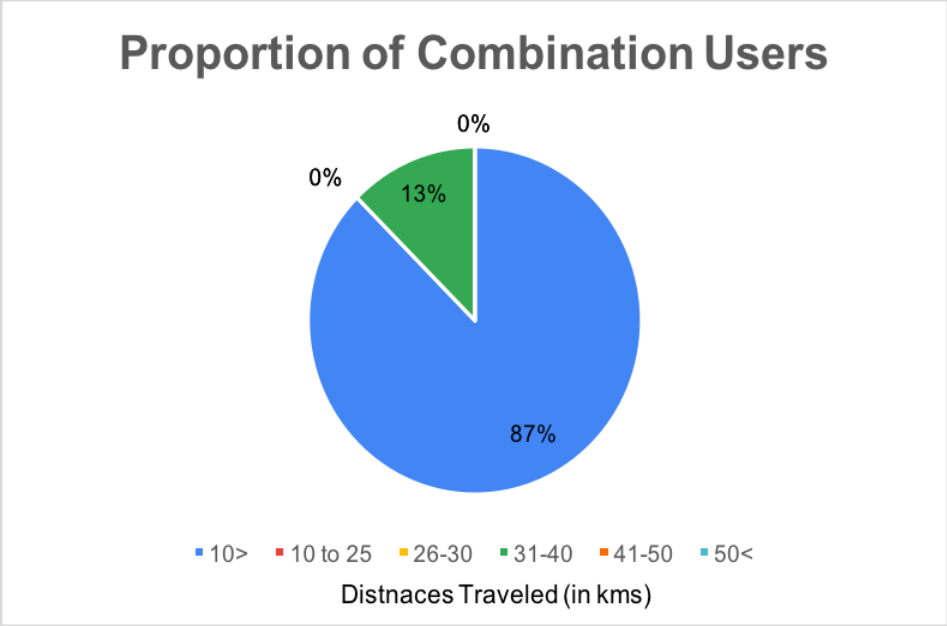

Figure 10: Proportion of Combination Users

Distance (in km)	Carpool
10>	0.7
10 to 25	0.1
26-30	0.2
31-40	0
41-50	0
50<	0
TOTALS	1

Distance (in km)	Independent Drivers
10>	0.488888889
10 to 25	0.311111111
26-30	0.022222222
31-40	0.088888889
41-50	0.044444444
50<	0.044444444
TOTALS	1

Distance (in km)	Public Transportation
10>	0.676470588
10 to 25	0.205882353
26-30	0.058823529
31-40	0.029411765
41-50	0
50<	0.029411765
TOTALS	1

Distance (in km)	UTM Shuttle
10>	0
10 to 25	0
26-30	0
31-40	0.75
41-50	0
50<	0.25
TOTALS	1

Distance (in km)	Non-Motorized
10>	1
10 to 25	0
26-30	0
31-40	0
41-50	0
50<	0
TOTALS	1

Distance (in km)	Combination
10>	0.875
10 to 25	0
26-30	0
31-40	0.125
41-50	0
50<	0
TOTALS	1

Figure 11: Data Tables for Proportion Pie Graphs

Supplementary Calculations :

A_1 = Public Transport A_2 = Drive Independently A_3 = Carpool A_4 = Non-Motorized A_5 = UTM Shuttle A_6 = Combination of Methods P(A1) = 34/104 P(A2) = 45/104 P(A3) = 10/104 P(A4) = 3/104 P(A5) = 4/104 P(A6) = 8/104	B_1 = < 10 B_2 = 10 - 25 B_3 = 26 - 30 B_4 = 31 - 40 B_5 = 41 - 50 B_6 = > 50 P(B1) = 62/104 P(B2) = 22/104 P(B3) = 3/104 P(B4) = 11/104 P(B5) = 2/104 P(B6) = 4/104

Public Transport (A1)	Drive Independently (A2)	Carpool (A3)
$P(A1 \mid B1) = \frac{23}{62}$ $P(A1 \mid B2) = \frac{7}{22}$ $P(A1 \mid B3) = \frac{2}{3}$ $P(A1 \mid B4) = \frac{1}{11}$ $P(A1 \mid B5) = 0$ $P(A1 \mid B6) = \frac{1}{4}$	$P(A2 \mid B1) = \frac{22}{62}$ $P(A2 \mid B2) = \frac{14}{22}$ $P(A2 \mid B3) = \frac{1}{3}$ $P(A2 \mid B4) = \frac{4}{11}$ $P(A2 \mid B5) = 1$ $P(A2 \mid B6) = \frac{1}{2}$	$P(A3 \mid B1) = \frac{7}{62}$ $P(A3 \mid B2) = \frac{1}{22}$ $P(A3 \mid B3) = 0$ $P(A3 \mid B4) = \frac{2}{11}$ $P(A3 \mid B5) = 0$ $P(A3 \mid B6) = 0$
Non-Motorized (A4)	**UTM Shuttle (A5)**	**Combination of Methods (A6)**
$P(A4 \mid B1) = \frac{3}{62}$ $P(A4 \mid B2) = 0$ $P(A4 \mid B3) = 0$ $P(A4 \mid B4) = 0$ $P(A4 \mid B5) = 0$ $P(A4 \mid B6) = 0$	$P(A5 \mid B1) = 0$ $P(A5 \mid B2) = 0$ $P(A5 \mid B3) = 0$ $P(A5 \mid B4) = \frac{3}{11}$ $P(A5 \mid B5) = 0$ $P(A5 \mid B6) = \frac{1}{4}$	$P(A6 \mid B1) = \frac{7}{62}$ $P(A6 \mid B2) = 0$ $P(A6 \mid B3) = 0$ $P(A6 \mid B4) = \frac{1}{11}$ $P(A6 \mid B5) = 0$ $P(A6 \mid B6) = 0$

Conclusion:

We anticipated that the closer a student lives to UTM the more likely they are to use public transit, and the farther they live, the more likely they are to drive independently. The conditional probability we calculated about a transportation method given a certain distance complements the information portrayed in Figures 5 through 10.

The probability a student uses transportation given they travel less than 10km to school is 37%. The probability a student's method of transportation is driving independently given they live less than 10km away from school is 35%. In addition to finding the conditional probabilities, we also calculated the proportion of students who use a given transportation method. 68% of the proportion of students use public transportation live less than 10km away from school. Whereas 49% of the proportion of students who drive independently live less than 10km away from school.

Furthermore, the probability a student uses public transportation given they live within 10-25km of UTM is 31%. The probability a student drives independently given they live within 10-25km of UTM is 64%. In addition, 20% of the proportion of students who use public transportation live within 10-25km of UTM. 31% of the proportion of students who drive independently live within 10-25km of UTM.

For distances greater than 25km, methods of transportation follow a similar trend of proportions.

We see that 75% of students that utilize the UTM Shuttle live 31-40km from campus, which is justified as the St.George campus is 33kms away from UTM. This statistic suggests that the students that use the UTM Shuttle to get downtown must live within a close radius of the St. George campus.

We conclude that the farther a student lives the more likely they are to drive than use public transportation, although some students do still use public transportation. The closer a student lives the more likely they are to use public transportation or drive independently. Although it is not as inversely proportional as we anticipated. Lastly, we observed that all students that use non-motorized transportation, live less than 10kms from campus.