So, How Did the Student Cross the Road? - An Investigation into Improving SUNY Fredonia Pedestrian Traffic

Village of Fredonia, SUNY Fredonia

Final Report

Kampbell Howard, Matthew Barton, Jake Pachucinski

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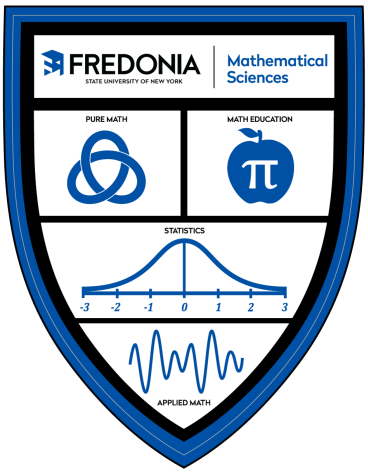

Department of Mathematical Sciences, SUNY Fredonia
Supervisor: Dr. Lan Cheng

Abstract

Hundreds of students at SUNY Fredonia walk to campus everyday to go to class. However, many of the streets surrounding the campus do not have convenient crosswalks, forcing students and pedestrians to jaywalk and put themselves at a significant risk of getting injured. By using two sample t-tests, Average Annual Daily Traffic data (AADT) statistics, time series analysis, and quantitative reasoning, one can determine the best type of signage that would allow students to safely cross Temple Street and Brigham Road. These methods lead to us proposing two raised crosswalks on Brigham Road and one striped crosswalk on Temple Street.

Introduction

The three main roads that surround SUNY Fredonia's campus are Temple Street, Brigham Road, and Central Avenue (Figure 1.1). While Central Avenue has two crosswalks that lead directly to the campus, neither Temple nor Brigham have ways for off-campus students to safely arrive to class. Also, most off-campus housing is located on either Temple Street or Brigham Road causing hundreds of students to jaywalk everyday. This information led us to focus on creating safe and efficient ways for people to access SUNY Fredonia's campus when crossing those two streets.

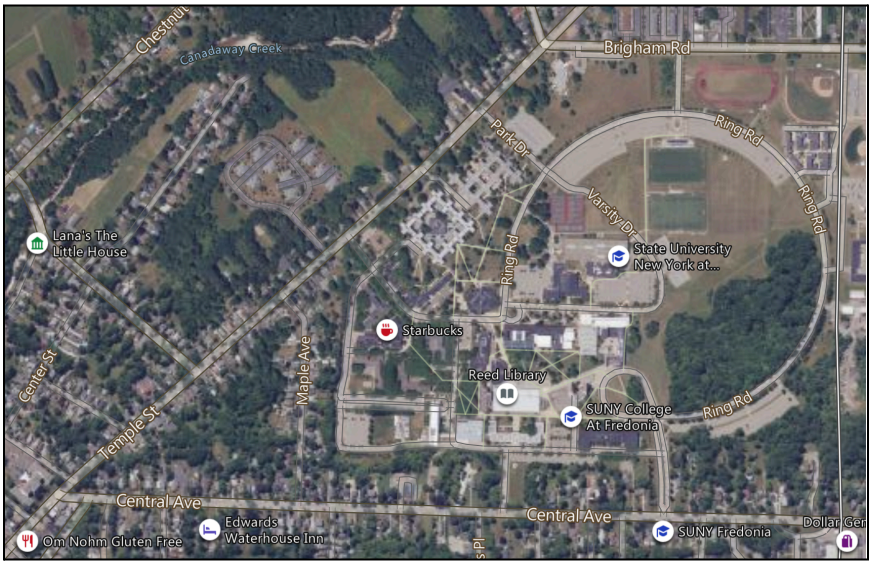

Figure 1.1 An aerial view of SUNY Fredonia to show that the surrounding roads of the campus are Temple Street, Brigham Road, and Central Avenue.

Using the Average Annual Daily Traffic data (AADT) statistics from https://gisportalny.dot.ny.gov/portalny, we analyzed the average car speeds, 85th percentile car speeds, and average daily traffic on both Temple Street and Brigham Road (2010-2019). This analysis led us to conclude that people were driving at significantly higher speeds on Brigham Road, both roads (on average) had cars driving above the speed limit, and the average daily traffic was below 9000 vehicles for Temple and Brigham separately.

These results led us to conclude that road signs would be necessary to warn drivers of the upcoming crosswalk(s) ahead. Cars traveling at high speeds need ample time in order to assess if a pedestrian is waiting to cross the road and then come to a complete stop. Also, long-time residents of Fredonia would need to become aware of the newly implemented signs since there has never been a crosswalk in these areas before.

This paper provides evidence that two raised crosswalks should be added to Brigham Road and one striped crosswalk added to Temple Street for students and pedestrians to safely access SUNY Fredonia's campus.

Methodology

A significant proportion of SUNY Fredonia students live on Temple and Brigham where they have the ability to walk to school. Further investigation will be done to estimate this number with various models, but this is an assumption for now. However, no matter the student population walking to school, it should still be a priority of the town to make their travel as safe as possible. Little to no current crosswalks exist (see Figure 1.4) causing students to "J-Walk" and risk being hit/injured. Reasons such as these contribute to high pedestrian-vehicle collisions and the increase in pedestrian fatalities in recent years which can be seen in Figure 1.2.

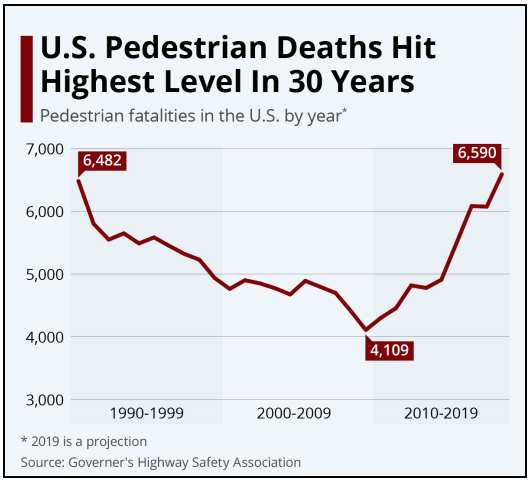

Figure 1.2 Pedestrian-Vehicle Collisions Resulting in Death in the United States from 1990 to 2019.

By incorporating new signage, alongside crosswalks, we wished to limit the current risk of the existing minimal safe crossings. Thus, investigation was done into what type of signage and where specifically the sign(s) should be posted relative to the crosswalk for maximum effectiveness. We focused our attention on Average Annual Daily Traffic data (AADT) and used the 50th and 85th percentile speeds on both roads. We used this data in both a time series analysis and two sample t-tests. First, with the time series analysis, we wanted to see if drivers have changed their speed patterns over the years (Figures 4.1, 4.2, 5.1, 5.2, 6.1 and 6.2). Originally in 2010, speeds on Temple and Brigham were 30 and 34 respectively. Through this analysis we concluded that although driver's speeds have changed, they seem to fluctuate and are going back to what they were originally in the first reading available. Thus, there was a spike in speeds in 2013 and 2016 but they are going back down towards the speeds in 2010. This shows us that we should be okay with assuming the speed will be near the 2010 data.

We now want to use two sample t-tests to see if there was a statistically significant difference in the median speeds for Brigham and Temple. This would help us conclude if we should have different signage and different types of crosswalks on both roads. By using the median speeds, we saw that there was a statistically significant difference in speeds on Brigham and Temple. Furthermore, we found that Brigham had a greater median speed than Temple. Next, we turned our attention to the 85th percentile speeds. Upon viewing this data (Figures 4.1 and 5.1) we can see that 85% of drivers are driving at or below 40 mph and 35 mph on Brigham and Temple respectively. Thus, one can deduct that each road would need a different stopping

distance if there was a pedestrian crossing. We turned our attention to a chart provided by the Texas Department of Transportation which aligned with the Federal Highway Administration and the Manual on Uniform Traffic Control Devices. This chart allowed us to see that for a vehicle to stop traveling at the 85th percentile, they would need 100ft or 125ft advanced placement distance for 35 mph and 40 mph respectively (see Table 1 below). Therefore, we determined that we would need 100ft advanced placement for the 'Crossing Ahead' signs on Temple and 125ft advanced placement for the 'Crossing Ahead' signs on Brigham.

Minimum Advance Placement Distance[1] (ft)																		
Posted Speed or 85th Percentile (mph)	Condition A: Speed reduction and lane changing in heavy traffic[2]	Condition B: Deceleration to the listed advisory speed (mph) for the condition																
		B: Stop[3]	5[4]	10[4]	15[4]	20[4]	25[4]	30[4]	35[4]	40[4]	45[4]	50[4]	55[4]	60[4]	65[4]	70[4]	75[4]	80[4]
20	225	100[6]	NA[5]	NA[5]	NA[5]	—	—	—	—	—	—	—	—	—	—	—	—	—
25	325	100[6]	NA[5]	NA[5]	NA[5]	NA[5]	—	—	—	—	—	—	—	—	—	—	—	—
30	460	100[6]	NA[5]	NA[5]	NA[5]	NA[5]	NA[5]	—	—	—	—	—	—	—	—	—	—	—
35	565	100[6]	NA[5]	NA[5]	NA[5]	NA[5]	NA[5]	NA[5]	—	—	—	—	—	—	—	—	—	—
40	670	125	100[6]	100[6]	100[6]	100[6]	NA[5]	NA[5]	NA[5]	—	—	—	—	—	—	—	—	—
45	775	175	125	125	125	100[6]	100[6]	100[6]	NA[5]	NA[5]	—	—	—	—	—	—	—	—
50	885	250	200	200	200	175	150	125	100[6]	100[6]	NA[5]	—	—	—	—	—	—	—
55	990	325	275	275	275	225	225	200	150	125	100[6]	NA[5]	—	—	—	—	—	—
60	1,100	400	350	350	350	325	300	275	225	200	150	100[6]	100[6]	—	—	—	—	—
65	1,200	475	450	450	425	400	400	350	325	275	225	200	125	100[6]	—	—	—	—
70	1,250	550	525	525	525	500	475	450	425	375	325	275	225	150	100[6]	—	—	—
75	1,350	650	625	625	625	600	575	550	500	475	425	375	325	250	200	100[6]	—	—
80	1,475	750	750	725	725	700	675	650	600	575	525	475	425	350	300	225	150	—
85	1,575	850	850	850	825	800	775	750	725	675	625	575	525	475	400	325	250	150

Table 1 Minimum Advance Placement Distance Chart from the Texas Sign Crew Field Book. http://onlinemanuals.txdot.gov/txdotmanuals/sfb/manual_notice.htm

We looked at the speeds along Brigham Road and Temple Street recorded on the New York State Traffic Data Viewer website. One assumption we made before using this data is that the numbers provided are still valid today. This is because the data is from the years: 2010, 2013, 2016, 2018, 2019. Using this data allowed us to determine where to put a warning sign that lets drivers know a crosswalk is coming up, and gives them ample time to react. The website gives average speeds for both northbound and southbound, but we used the 85th percentile speeds that they provide to account for drivers that like to speed. The speed difference between northbound and southbound will allow us to put the signage where it is necessary, rather than placing it too

early, or too late. Furthermore, we wanted to consider if drivers behave differently depending on the road (i.e. speed greater on one compared to the other) so we could implement more safety measures if needed. This is where different methodologies of comparison by time-series plots and two sample t-tests provided us with useful information. More specifically, it allowed us to conclude that drivers are speeding greater on Brigham than that of Temple and make further suggestions as to where/how many signs should be placed on the road.

Figure 1.3 Different types of signage utilized in the final suggestion including crossing ahead, cross here, and elevated crosswalks.

Not only do we want to know where to put the signage, but we also want to know what signage would best fit Fredonia's budget and needs. The signage options include: yield signs, traffic lights, stop signs, Pedestrian Hybrid Beacons, raised pedestrian crosswalks, and regular crosswalks. While we will at least need a regular crosswalk, we looked at the other options to see what combinations could benefit the town and the safety of pedestrians. The websites used to investigate these factors are listed in the references down at the bottom of the report. This allowed us to obtain useful signage data and create a list describing the benefits, downfalls, and price estimates for each type of sign (See Table 2). This way the town of Fredonia can choose the one that will work best for their needs.

Analysis and Results

After analyzing all of the data we collected, we determined locations for three safe crossing measure implementations using our data from Table 2. First note some of the results we obtained to determine where and why we are choosing these ideas.

- When conducting two sample mean tests on the differences in 50th percentile speeds on Brigham and Temple (see Figure 2 and 3), we see that whether it was a two-sided or one-sided test, we obtained a statistically significant p-value. This means that there is a difference between median speeds on these two roads even though their speed limits are the same (30 mph). From this we can conclude that two different implementations are required for both roads; more specifically one that calms the traffic on Brigham both Northbound and Southbound. Therefore, we need a raised crosswalk that needs to be away from openings that allow people to exit or enter Brigham.

- We can also see in aerial views of the road that there are sidewalks on both sides of the road, leading toward the road, encouraging unsafe crossing; which we want to eliminate. Furthermore, to service both Park Place and Campus Edge, we think that two safe crossing implementations on Brigham and one safe crossing implementation on Temple. Another thought is that upon seeing the graphs of Annual Average Daily Traffic (AADT) per year on each road (Figures 7.1 and 7.2), we can assume that our AADT will stay around those values for years to come and stay under 9000 AADT.

- Another consideration that needs to be made is that some trucks and buses take Brigham and thus it would be hard for these vehicles to travel on a raised crosswalk. However, after looking at the Truck AADT, we can see that it is estimated that only 167 trucks travel this road both ways daily (Figure 8). With this in mind, that is only 4% of traffic per year according to the 2019 statistic. Furthermore, if a truck wanted to travel in this same direction, they could take a different route (this is outlined in the next section).

- The last consideration we need to make is that if we were to create new crosswalks, we need to consider that there may be sewer pipes below where we need to dig and consider the cost of foundations for sidewalks. As seen in Figure 9, we can see the cost of sidewalks are about $500 to $800 including foundation per 100 square feet. This would include foundation and installation based on numerous sources.

Proposal and Conclusion

Based on the AADT on these two roads, cost, speed, and efficiency, we propose the following (which can be see in Figures 10.1 and 10.2):

1) We place a Raised Pedestrian Crossing at Point A and Point B. Furthermore, we place 'Crossing Ahead' signs at 125 feet before each crossing in both directions. Also, we would place crossing signs on both sides of each Raised Pedestrian Crossing. Furthermore, we are proposing a sidewalk on the west side of the crossing at Point B. This would cost at least an additional $800. Thus, this would result in an estimated cost of $40,600.

2) We place a Striped Crosswalk at Point C and two 'Crossing Ahead' signs which are 100 feet before the crossing in both directions. This would result in an estimated cost of $1,970.

3) Trucks wishing to travel on the stretch of Brigham where the Raised Crosswalks will be placed can either take that road or take an alternative route. This would be three separate routes depending on the road on which the truck is starting on. First, trucks that are originally on Route 5 that need to travel in towards Fredonia, can continue to take Route 5 until the intersection with Temple St. These trucks would end at the same intersection as Brigham after the college entrances on Brigham. Second, if trucks are already on Brigham, they can take Willow to Chesnut to Matteson to get to the same intersection. If the truck is really just trying to go from Dunkirk to Fredonia, they can also take any of the side streets that are eastbound to get onto Central Avenue. In sum, there are many

different routes a truck could take if the raised crosswalk is not compatible with their vehicle.

Thus, in total, our proposed plan would cost just over $42,000 on average. After our several levels of analysis and evaluation, we conclude that there should be two raised crosswalks on Brigham and one striped crosswalk on Temple.

Future Work and Limitations

There are several different directions for future work or limitations in our proposal. To begin, some limitations start with our assumptions. We assumed that the data from previous years is still valid today. This is an assumption that might be invalid because after COVID, there may be different AADT's that would be calculated after the pandemic. Furthermore, there may be a decrease in student attendance over the past couple of years at Fredonia which may lead to less traffic in the area. Another limitation would be that we are assuming that a couple hundred students are living at Park Place and Campus Edge and most if not all are walking during the 'nicer' months. Also, a limitation could be that we did not consider the fact that there may be sewage pipes underneath our proposed crosswalks. One direction for future work from this is to send out a survey or obtain data from these residences and see how many people walk to school and how many are driving. Another limitation would be that we did not have access to the transportation budget of Fredonia. Thus, we were not able to make recommendations based on their budget. Therefore, we would be just factoring in what looks best for the data, not what is best for Fredonia's budget. Lastly, one direction for future research would be to look at a longitudinal study of conducting safety data before and after implementing our proposed plan to see its effectiveness.

Acknowledgements

Thank you to Dr. Lan Cheng for her continued support with the project and to the Village of Fredonia for working with the SUNY Fredonia Department of Mathematical Sciences. We greatly appreciate and value the knowledge and education we have received and attribute the success of this report to both parties.

Appendix

Table 2. Pedestrian Signage Options with Cost and Usage Statistics

Pedestrian Safe Crossing Options			
Name	**How They Work**	**Typical Usage (AADT Level and MPH)**	**Mean Cost per Unit**
In-Street Pedestrian Crossing Sign	Sign is placed in conjunction with a crosswalk to alert drivers to yield to pedestrians.	> 10,000 vehicles and < 30 mph	$240
Crossing Sign	Provides drivers with advanced notice	N/A	$300
Striped Crosswalk	Pedestrians would have a striped crosswalk to cross the road.	< 10,000 vehicles	$770
High Visibility Crosswalk	Pedestrians would have a striped, highly visible (reflective) crosswalk to cross the road.	< 10,000 vehicles	$2,540
Raised Pedestrian Crossing	Pedestrians would cross the road on a raised concrete pavement. This would act as a speed bump as well as make it apparent to drivers that pedestrians could be crossing.	< 9000 Vehicles and < 30 mph	$19,000
Rectangular Rapid-Flashing Beacon	Pedestrians would press a button to indicate crossing and a strobe-like warning would be given to drivers. Used in conjunction with a painted crosswalk.	< 40 mph	$22,250
Pedestrian Hybrid Beacon (PHB)	Pedestrians would press a button to activate a red light for drivers.	> 9000 vehicles	$57,680
Information obtained from http://www.pedbikesafe.org/PEDSAFE/countermeasures.cfm			

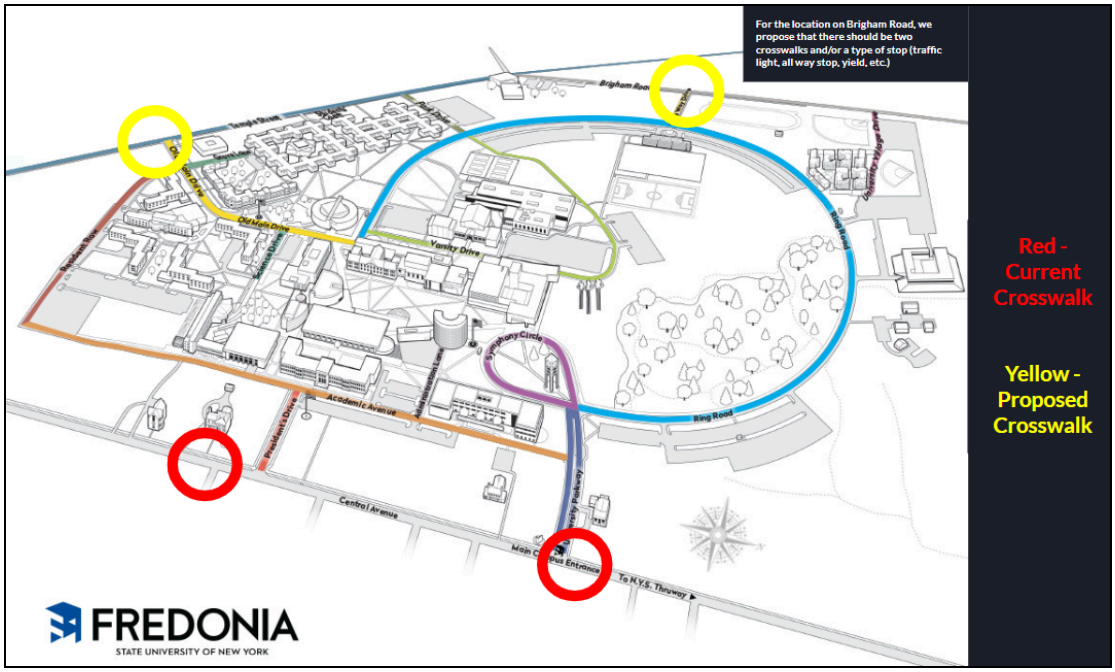

Figure 1.4 Map of SUNY Fredonia showing current and potential safe crossings as suggested by our team.

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        Welch Two Sample t-test

data:  Brigham_Combined$FIFTYTH_PERCENTILE_SPEED and Temple_Combined$FIFTYTH_PERCENTILE_SPEED
t = 3.414, df = 3.4159, p-value = 0.03443
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.5691611 8.2641722
sample estimates:
mean of x mean of y
 35.75000  31.33333
```

Figure 2. Two-tailed two sample t-test results between Brigham and Temple Street using 50th percentile speed data. Based on the p-value of 0.03443, the results are significant at a 0.05 significance level, thus there is a difference in the 50th percentile speeds on the two streets.

```
        Welch Two Sample t-test

data:  Brigham_Combined$FIFTYTH_PERCENTILE_SPEED and Temple_Combined$FIFTYTH_PERCENTILE_SPEED
t = 3.414, df = 3.4159, p-value = 0.01722
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
 1.517504      Inf
sample estimates:
mean of x mean of y
 35.75000  31.33333
```

Figure 3. One-tailed two sample t-test results between Brigham and Temple Street using 50th percentile speed data. Based on the p-value of 0.01722, the results are significant at a 0.05 significance level, thus the mean 50th percentile speed on Brigham is greater than that of Temple. This infers that Brigham should be considered for more implementation of safety precautions at safe-crossings.

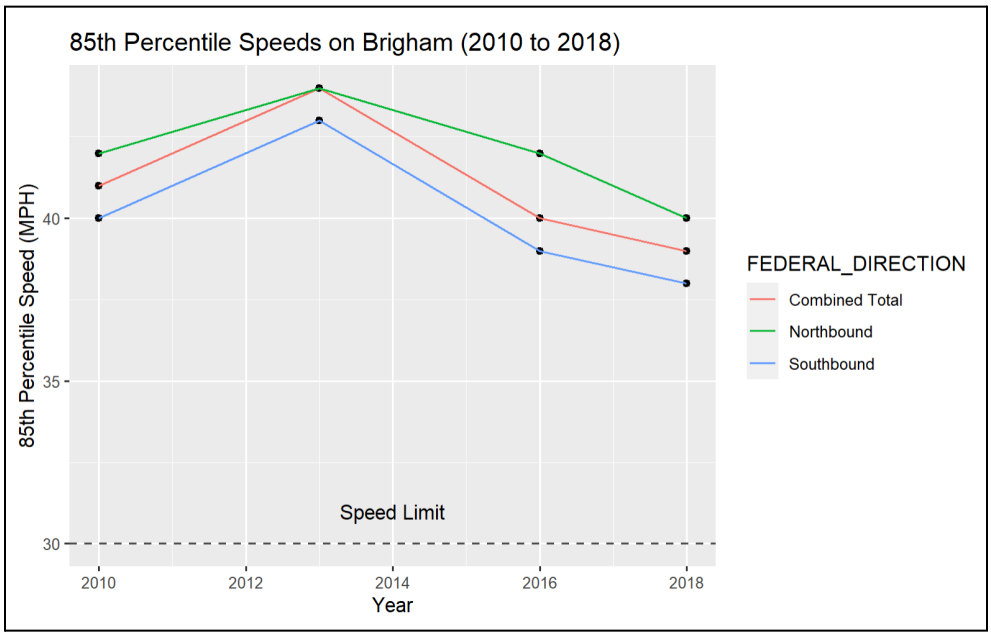

Figure 4.1 Time series plot comparing 85th percentile speeds of drivers on Brigham from 2010 to 2018. It appears that northbound drivers are on average faster than southbound drivers and the northbound direction could be considered for implementation of more safety measures.

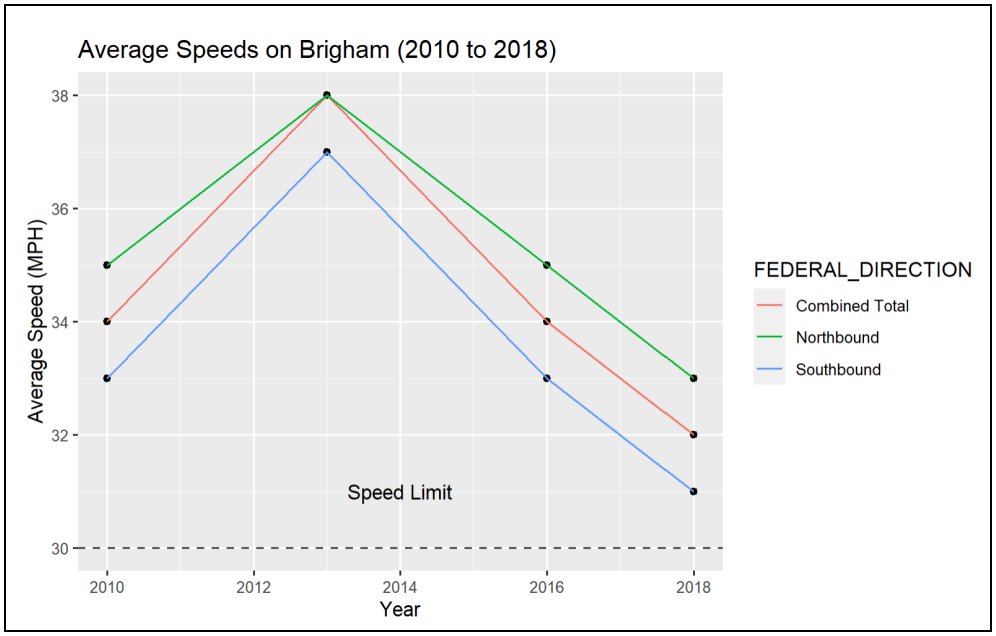

Figure 4.2 Time series plot comparing average speeds of drivers on Brigham from 2010 to 2018. It appears that northbound drivers are on average faster than southbound drivers and the northbound direction could be considered for implementation of more safety measures.

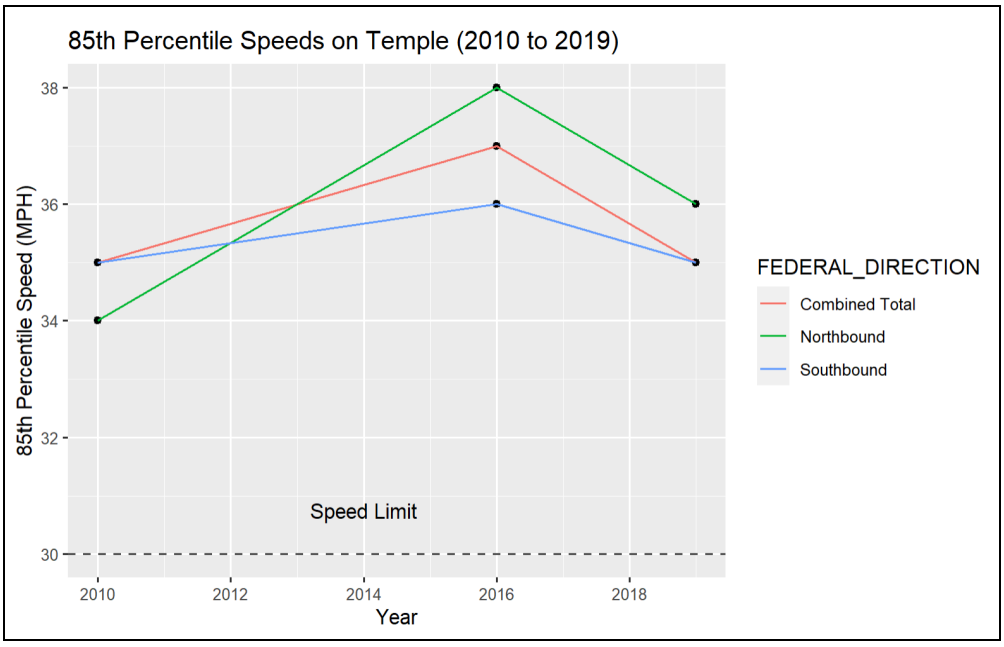

Figure 5.1 Time series plot comparing 85th percentile speeds of drivers on Temple from 2010 to 2018. It appears that northbound drivers are on average faster than southbound drivers in recent years and the northbound direction could be considered for implementation of more safety measures.

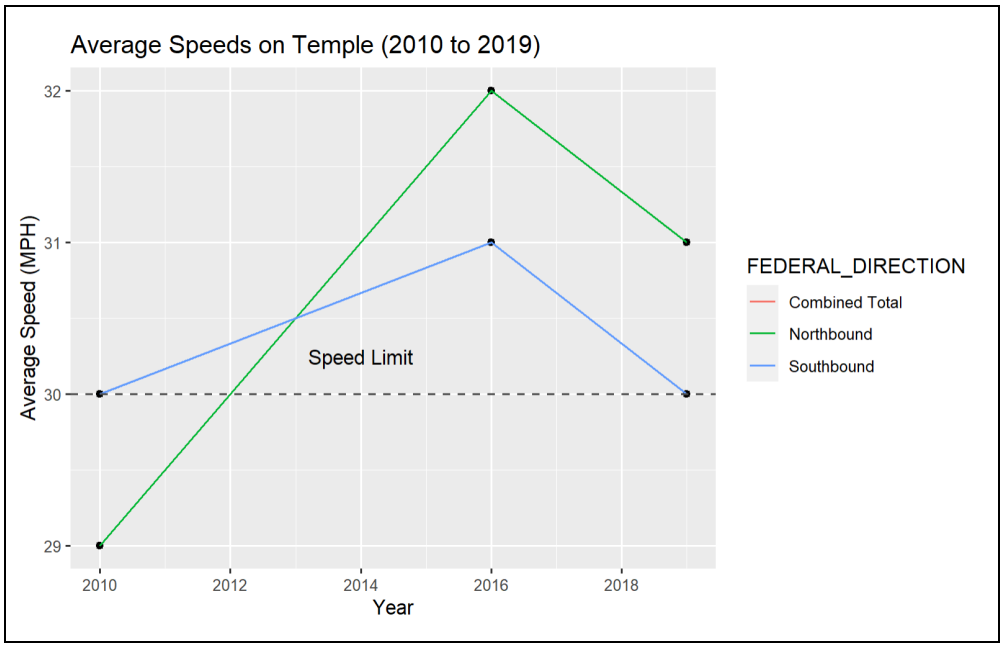

Figure 5.2 Time series plot comparing average speeds of drivers on Temple from 2010 to 2018. It appears that northbound drivers are on average faster than southbound drivers in recent years and the northbound direction could be considered for implementation of more safety measures. Note that the combined total line is plotted directly below the "Northbound" line.

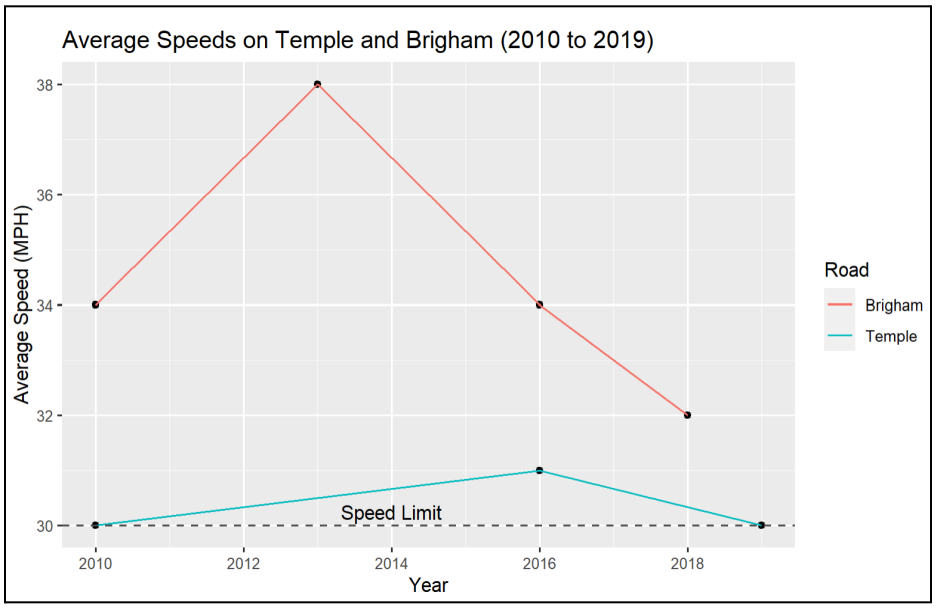

Figure 6.1 Time series plot comparing average speeds of drivers on Temple and Brigham from 2010 to 2018. It appears that drivers on Brigham are faster than Temple and Brigham could be considered for implementation of more safety measures. This difference in the speeds of these two average speeds is statistically significant, as outlined in Figure 2 and 3. In either case, drivers are speeding over the speed limit.

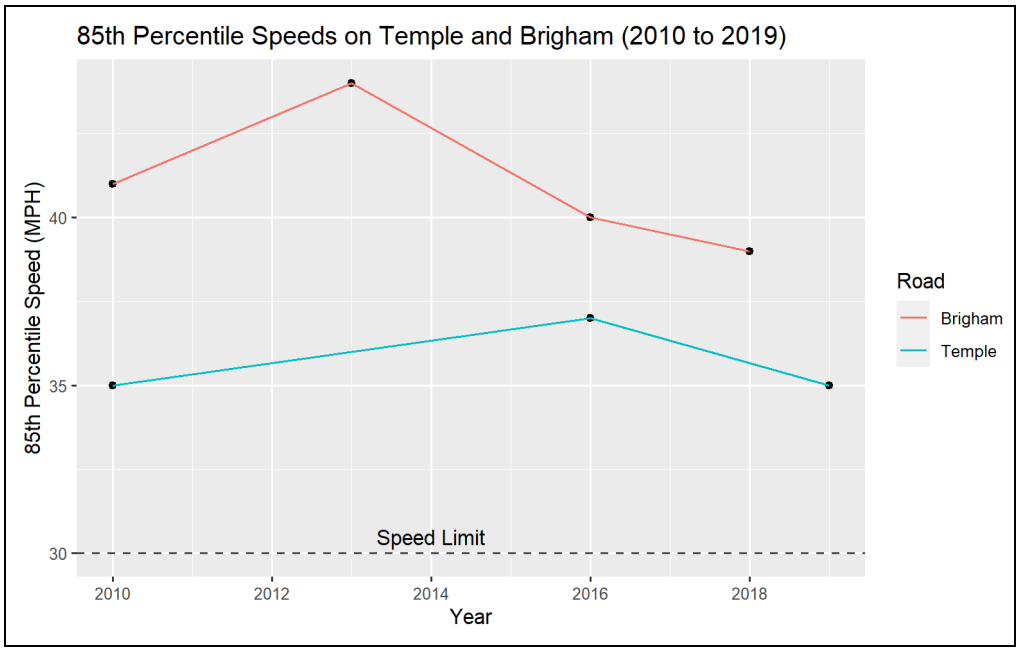

Figure 6.2 Time series plot comparing 85th percentile speeds of drivers on Temple and Brigham from 2010 to 2018. It appears that drivers on Brigham are faster than Temple and Brigham could be considered for implementation of more safety measures. This difference in the speeds of these two average speeds is statistically significant, as outlined in Figure 2 and 3. In either case, drivers are speeding over the speed limit.

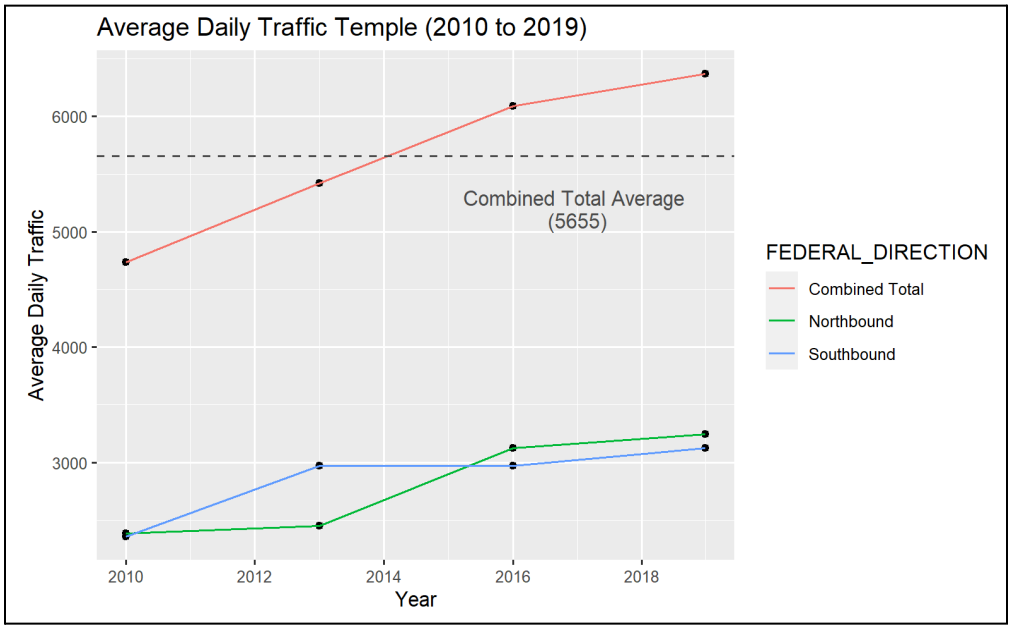

Figure 7.1 Time series plot of the annual average daily traffic (AADT) on Temple from 2010 to 2019. It appears that traffic increased over those 10 years and that the AADT is less than 9000 vehicles per day.

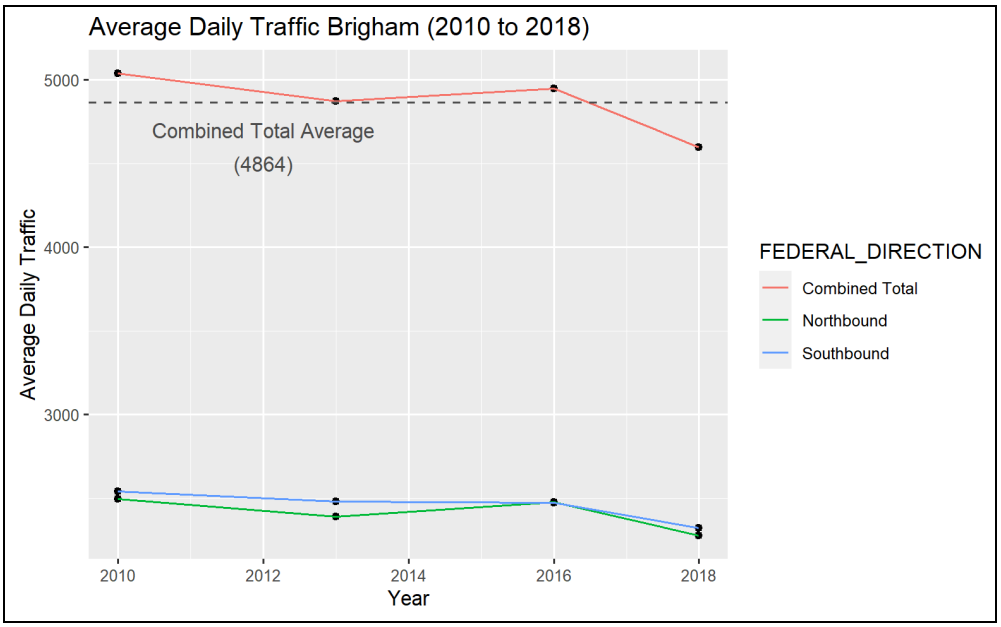

Figure 7.2 Time series plot of the annual average daily traffic (AADT) on Brigham from 2010 to 2018. It appears that traffic increased over those 10 years and that the AADT is less than 9000 vehicles per day.

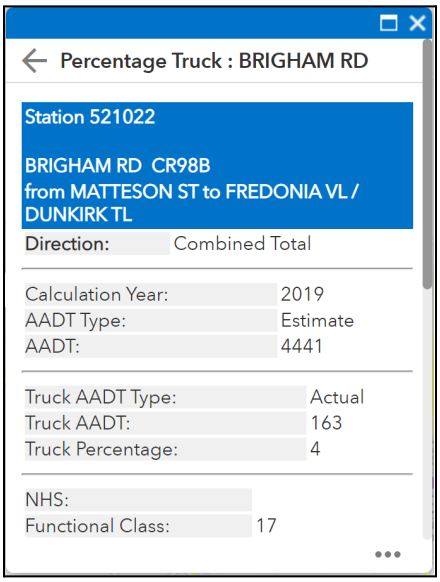

Figure 8 Truck AADT Percentage on Brigham Road in 2019.

Sidewalk Size	Average Cost
3-by-20 feet (60 sq.ft.)	$360 - $720
4-by-20 feet (80 sq. ft.)	$480 - $960
5-by-20 feet (100 sq. ft.)	$600 - $1,200
3-by-40 feet (120 sq. ft.)	$720 - $1,440
4-by-40 feet (160 sq. ft.)	$960 - $1,920
3-by-60 feet (180 sq. ft.)	$1,080 - $2,160
5-by-40 feet (200 sq. ft.)	$1,200 - $2,400
4-by-80 feet (320 sq. ft.)	$1,920 - $3,840

Figure 9 Costs of sidewalks on average based on https://www.homeadvisor.com/cost/outdoor-living/concrete-sidewalk/

Figure 10.1 Proposed locations of Raised Pedestrian Crossings on Brigham.

Figure 10.2 Proposed location of painted crosswalk on Temple.

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