COST BENEFIT ANALYSIS: SCRAMBLE CROSSWALK

ECON 392:003 Group 4

CSU Honor Pledge
"I have not given, received, or used any unauthorized assistance"

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Executive Summary

In this Cost-Benefit Analysis we will study the implementation of a scramble, or Barnes Dance, crosswalk in Old Town Fort Collins, Colorado. A scramble crosswalk changes the traditional two-phase traffic cycle into a three-phase cycle, providing a phase for pedestrians to use the entire intersection. The implementation of the proposed project would have a primary market of traffic efficiency in the target area, attempting to improve efficiency for both vehicles and pedestrians. The secondary markets for this project include, but are not limited to, environmental and construction markets. In this analysis we will study the benefits to drivers through value of time saved no longer waiting for pedestrians in the crosswalk and the lost benefits to pedestrians through a longer average wait time to cross the intersection. We will also study the benefits of the program regarding fuel, including both gas saved from less time idling and the environmental benefits of less CO₂ added to the air. Each of these benefits will be incurred annually and are thus discounted over the life of the project. There are also unmonetized benefits of this project, including reduced driver frustration and social benefits, that we take into consideration in our analysis. The costs that would be involved in this project include the repainting and reprogramming of the intersection to create the scramble crosswalk, a public
information campaign to educate the public on the change, and a temporary increase in police presence at the intersections to help people navigate the altered intersection and address any temporarily increased safety concerns. These costs are all incurred when the project is implemented and do not require future payments. The final cost involves the environmental cost of cars waiting for pedestrians during the pedestrian phase of the traffic cycle, which will be calculated in the same manner as the environmental benefits and will be discounted over time. Through our analysis we find that the net present value of the costs and benefits of the project are positive and recommend that the city implement the project at both intersections.

Fort Collins Strategic Initiative

The Fort Collins Strategic Initiative is the plan for the city moving forward into future years, setting goals for what municipal leaders hope to accomplish. The 2016 plan was organized into seven areas ranging from culture and recreation to high performing government (2016 Strategic Plan, 3). One of these areas was transportation, in which the Fort Collins government laid out its goal to provide “safe and reliable multi-modal travel to, from and throughout the City” (2016 Strategic Plan, 34). To break up this big-picture goal the city established seven sub-goals that were more clear and attainable in the near future. With this project we hope to assist the city in reaching goals 6.1, 6.2, and 6.5, which cover improving multi-modal transportation, traffic flow, and the aesthetic environment (2016 Strategic Plan, 35). In helping the city accomplish these goals, we hope that the City of Fort Collins will be a better place to live.

Project Description

The project we are proposing is to implement scramble crosswalks in Old Town Fort Collins, specifically where College Ave. intersect Mountain Ave. and Olive St. Scramble crosswalks, also known as Barnes Dance crosswalks, have three-phase traffic cycles instead of two. There are the two traditional phases where only cars cross the intersection followed by a
third phase when pedestrians are able to cross the intersection in any way they would like. This includes crossing the intersection diagonally. During the vehicle phases of the traffic cycle pedestrians will not be allowed in the intersection in order to increase efficiency for vehicle travel as those vehicles would no longer need to wait for pedestrians in the crosswalk in order to make a turn.

Scramble crosswalks have been implemented in other cities throughout the nation and around the world. The system was popularized by Henry Barnes in Denver and New York City as a way to make intersections more pedestrian friendly (Jaffe 2012). In recent years the Barnes Dance has seen a resurgence in popularity as cities start to focus more on making their infrastructure more pedestrian friendly. Cities that have recently added scramble crosswalks include Toronto, London, and Washington D.C. (Jaffe 2012). The project tends to work best when there is a high volume of pedestrian traffic in the intersection, allowing for greater efficiency in pedestrian traffic as they no longer need to wait at each corner to cross two ways. According to a case study of the implemented scramble crosswalks in Toronto, the design worked best when diagonal crossing distances were longer, lower numbers of pedestrians crossed the street diagonally, and when pedestrians made up a lower percentage of total intersection traffic (NYC Department of Transportation). Other smaller towns, including Walnut Creek, CA, have implemented scramble crosswalks in order to accommodate for greater growth in pedestrian use of shopping mall intersections (City of Walnut Creek). In Fort Collins, studying the option of implementing a scramble crosswalk in Old Town provides the possibility of realizing some of the potential that other cities have.

**Theoretical Modeling and Identification**

The implementation of this project will bring with it a number of benefits and a number of costs as well in the primary and secondary markets we will study. In this analysis, the primary
market will encompass traffic efficiency in Fort Collins. This includes both pedestrian and vehicular traffic, which we believe to be currently inefficient. Secondary markets that will also be affected by the implementation of this project include Fort Collins air quality, Old Town business traffic, social well-being, road painting and construction, and traffic controllers. All of these markets are expected to see either costs or benefits from the project’s implementation, as we will detail below.

One of the key benefits of the crosswalk improvement will be increasing the traffic flow in Old Town. Cars will more easily be able to make left or right hand turns at the intersections in question, which will free up lanes more quickly and improve overall efficiency. This is a direct benefit of the program and will be calculated by observing the amount of time the average vehicle waits to make a turn due to pedestrians in the crosswalk, how often this happens, and the average value of a person’s time. We will also see how often a lane is backed up because of someone who is trying to make a turn being unable to do so. This calculation will allow us to monetize one aspect of the direct benefits of the project.

Next, we will look at efficiency in pedestrian traffic. Improving pedestrian traffic flow will also be a direct benefit of the project through the ability of pedestrians to walk directly across the intersection instead of going the long way around. This benefit can be monetized in the same way as the previous benefit discussed.

The possibility of increased foot traffic to the stores in old town, thus increasing their business, should be considered a direct benefit. The increased revenue received by each of the stores will mean that they pay more taxes to the city of Fort Collins. This will make this benefit more of a pecuniary effect then a real effect. It would be extremely difficult to be able to narrow
down what increases/changes are due directly to the proposed project and no other effects. Therefore, this benefits effects should most definitely be considered intangible.

The increased efficiency of both the foot traffic and the vehicle traffic should lead to far less road rage and aggressive driving incidents in old town. This direct benefit should allow for less expenses on emergency services in this area on a regular basis. Because these effects will likely only be localized in the Old Town area, this should be considered an internal effect that relates only to the patrons of Old Town. This will be a more real and tangible effect due to its cost savings on the reduced need for emergency services. We can calculate these cost savings by learning how many times on average is there an accident/incident related to road rage at or around these intersections.

The final benefit received from this project is the reduced environmental damage caused by reduced time that cars are sitting idle in intersections as well as reduced driving in general. This is more of a direct internal effect because it is going to be directly affected by this policy. It is going to be an additional benefit gained over time as traffic becomes more aware/used to the new system. Environmental benefits will also be a more pecuniary tangible effect because the population of Old Town is likely not to even notice the better air quality and even if they do it is unlikely they will attribute it to the new crosswalks. While all vehicles produce varying degrees of emissions, we will calculate the environmental benefits by taking the average CO₂ produced by vehicles and taking the average amount of time each vehicle waits on a pedestrian to turn.

Some of the benefits that this project would create for the City of Fort Collins are non-monetized due to the nature of the benefits and absence of clear means of monetization. One of these benefits is the reduction in driver frustration. Currently the presence of pedestrians in the crosswalks limit the ability for vehicles to make turns or create the potential for vehicles to
almost hit pedestrians that they did not see. These experiences would create considerable frustration for drivers, a frustration that this project would effectively eliminate. However, accurately monetizing the benefit of eliminating this short-term frustration is not feasible due to the absence of a viable secondary market to use to measure frustration and that individuals are unlikely to be able to accurately value their willingness to pay to remove such a frustration from their lives.

In addition to reduced driver frustration, there will be social and legal benefits to implementing this policy that are incredibly difficult to monetize but should be considered nonetheless. The social benefits of this project involve creating a more pedestrian friendly environment. As mentioned earlier, one of the founding purposes of the Barnes Dance was to make intersections more accessible for pedestrians. Doing so will provide social benefits for Old Town pedestrians as they find the area easier to use. Monetizing this benefit, though, would be difficult as pedestrians, especially those unfamiliar with how a scramble crosswalk works, would be unable to provide an accurate estimate of their willingness to pay for the change. It may be that some of these benefits are captured in the monetized benefits described above as a quasi-secondary market, but social benefits of the project should still be taken into consideration in the decision-making process as a possible for surplus gains. There will also be legal benefits for drivers in Old Town as the project will hopefully cut down on illegal right-hand turns at a red light on College Ave. With no perceived enforcement of the law here it is difficult to monetize the value to drivers of no longer breaking the law, but it should still be considered as a potential benefit of the program.

There are multiple costs associated with our project, for the most part incurred in secondary markets outside of traffic efficiency. First, we must to account for the direct cost of repainting
the intersection and re-programming the light. As our main purpose is to increase the flow of traffic, we will have to reprogram the light so that we can efficiently utilize the new traffic design while balancing the wait time between pedestrians and drivers. Secondly, we may also need to add the no-right-hand turn light to avoid any unsafe maneuvers made by drivers used to the status quo. In addition, the project will require new signs to be made for each street corner so that pedestrians have instructions on how to use the new system. From an economic perspective, the above mentioned direct costs includes materials, labor and technological expenses, that are all direct, and tangible.

Outside of physical items that would incur costs as part of the project, there are some soft costs that the city will have to be aware of. First, some form of public information campaign will need to be put on by the city to inform the populace of the project and instructions on how to use the new system. This can be done at a relatively low cost through online means and perhaps a public forum, all of which have been done before by the city for other projects and will therefore be relatively easy to monetize. In addition, it would be helpful for the city to pay for some extra police presence in the area during the first couple of weekends with the new program to help make sure that people are able to adapt to the change. This cost can also be easily monetized through calculating the necessary man-hours the project would require from the police force and what that would cost the city. Both of these costs are direct expenses for the project.

We started the monetization of each of the benefits by collecting a large amount of data from the city and attempting to collect as much information possible from times this project was implemented in other cities. Unfortunately, we were unable to collect much information from other cities that had implemented similar projects. We were able to get a significant amount of information from the city of Fort Collins regarding the two intersections where the project would
be implemented. This information included the number of cars that turned at each intersection throughout the day as well as the number of pedestrian-related accidents that occur at these intersections. The data provided by the city illustrated that the safety benefits that would stem from this project would so negligible that we will not include it in the monetization of the benefits. Specifically, there were only four pedestrian related accidents in four years, none of which were significant enough to result in a monetary cost to any party (Olsen). We also collected a large amount of data regarding how long cars wait for pedestrians when turning, as well as an estimation of the number of cars that must wait on pedestrians. To increase the accuracy of the analysis, we chose to do separate analyses for each of the intersections rather than doubling the results of either of them.

**Monetization of Benefits**

After we were able to collect the necessary information, we were able to begin calculating the benefits of implementing this project. We began with the surplus that is wasted by cars waiting to turn at the intersection of Olive St. and College Ave. This was calculated by determining how long, on average, each car waits for a pedestrian. We also took the average amount of time a car takes to turn with no pedestrians present so as to diminish the possibility of over-estimating any benefits. This came out to be 12.02 seconds for the time each car takes to turn when waiting, and 1.24 sec for when pedestrians are not present. When calculating the value of people’s time we used the average salary earned by citizens of Fort Collins, which equates to roughly $24.84 per hour (U.S. Census). The number of cars that turn right on a daily basis at this intersection is roughly 3,246 (City Docs). Using the average amount of time taken to turn right with pedestrians, 12.02 sec, roughly 3,955.88 hours are lost per year from this delay. As stated previously, even when there is not a pedestrian present a small amount of time is wasted and therefore must be considered. This smaller delay accounts for roughly 408.1 hours when no
pedestrians are present. These numbers, combined with the average hourly wage and subtracting the wage lost even without pedestrians present, equals $88,127.05. This would be the direct yearly benefit to drivers at the intersection of Olive St. and College Ave. from the implementation of this project and would be incurred with every year that the scramble crosswalk is utilized.

Next, we looked at the surplus gained from pedestrians’ time savings due to the implementation of a scramble crosswalk at the same intersection. To accomplish this, we used a similar method as above, but in this case we were given the average wait time for pedestrians of 30 seconds (City of Fort Collins). We used this number to determine how long it takes on average to cross the intersection twice without a diagonal option, which is 60 sec. We again observed the intersections to determine that around 10% of people crossing will have to cross diagonally. From Fort Collins traffic data we found that 1,103,760 pedestrians cross yearly. Using Fort Collins and observed data, we calculated that 10,117.8 hours of time is wasted by pedestrians having to wait to make two crossings. Using the average income for Fort Collins, we can determine that the value of time spent waiting yearly is $251,326.15. When doing this same calculation with the average wait time of 45 seconds, which would be the average with the new scramble crosswalks, we found that the time spent would be 13,797 hours annually, which monetized results in a value of $342,717.48. This means that the new scramble walk system will lose $91,391.30 annually for pedestrians in value of time lost. The negative value would be incurred every year of the program, and thus needs to be considered when discounting future benefits.

The last two benefits that need to be monetized are to the environmental benefits of the new crosswalk system. We determined these benefits by using the number of hours cars will sit
waiting for pedestrians, which was 3,955.88 hours, and the amount of gas that is burned on average by a car sitting at idle, 0.24 gallons per hour (Department of Energy, 2015). From here we calculated that 949.412 gallons of gas are burned every year by having to wait for pedestrians. Using this number, we can determine how much CO₂ is produced from vehicles idling using what the Energy Information Administration’s research, which states an average of 19.6 lbs of CO₂ is produced from one gallon of gas. This means that 9.3 tons of CO₂ is produced from vehicles involved in our study. Using the economic and social cost of CO₂, we can determine how much surplus would be gained through the implementation of this project. There is a bit of a disagreement as to what the social cost of carbon dioxide is, ranging from $37 to $220 per ton (Than 2015). This gives us a net benefit range of either $344.10 to $2,046 per year. We can also use the average price of gas in Fort Collins, roughly $2.37 per gallon, to determine that $2,250.10 will be saved by drivers on gas from no longer having to wait for pedestrians in the intersection.

Next, we looked at the intersection of Mountain Ave. and College Ave. While we could for the most part use the same equations and process as outlined above, there are roughly double the number of cars turning on a daily basis at this intersection (City Docs). We started with the annual time savings for drivers with the knowledge that 2,820,720 cars turn annually. Leaving all other numbers constant with the equations above, we calculated the value of time saved as $209,810.80 annually. This is unsurprisingly almost double that saved at Olive and College. We also determined that the number of pedestrians that crossed here was not actually that different from above. Thus, we used the same number for value of time lost for pedestrians with the new system, which is $91,391.30 annually. The environmental benefits also changed for this intersection due to the increased traffic. Leaving all other numbers constant, a total of roughly
22.15 tons of CO₂ is produced at this intersection. This leaves us with a social economic benefit of between $819.55 and $4,873 annually and total gas savings of $5,356.99. The combination of the two benefits to be anticipated at the two intersections as a result of the proposed project are included in the table below to provide a better understanding of the total net benefits of this project.

To calculate the total benefits of the project over the next 10 years calculated the net present value of the benefits using a 3.5% discount rate. This rate is recommended in Cost-Benefits Analysis: Concepts and Practice as a balanced rate that takes into account the opportunity costs associated with time value of money (Boardman, et. al. 2011). Using this discount rate over ten years and all of the annual benefits calculated above, we find that the net present value of the benefits range from $1.15 million to $1.2 million.

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<tr>
<th>Benefits</th>
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<tbody>
<tr>
<td>Total annual time saved: <strong>$297,938.85</strong></td>
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<tr>
<td>Total annual pedestrian time saved: <strong>-$182,783.60</strong></td>
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<tr>
<td>Total annual social cost reduction: <strong>$6919-$1163.65</strong></td>
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<tr>
<td>Total money saved annually: <strong>$7607.09</strong></td>
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<td>1st Year Total:$123,926.99- $129,681.34</td>
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Monetization of Costs

Implementing any policy to support a government’s strategic plan almost always incurs costs to the government and/or the community governed, whether they are direct, indirect, monetized, or non-monetized costs. To elaborate, direct costs are costs that affect a party in the direct market in which the policy is being implemented, while indirect costs are the costs to secondary market parties that result from the implementation of the policy. Moreover, monetized costs are costs that can be allocated through a value of money, while non-monetized costs are costs in which we cannot directly see a denominated value associated with it, usually to gauge the social cost to a policy. When doing a Cost-Benefit Analysis, it is imperative that all costs are calculated when deciding the potential net benefit that a new policy would produce. Additionally, these costs, much like the project benefits, may require an associated discount value, assuming that some costs are recurring and are not all incurred at one time. With the implementation of the scramble crosswalk, there are many costs to consider before Fort Collins decides on whether the project would benefit the government and community at large.

There are multiple costs associate with implementing a scramble crosswalk, mostly regarding construction costs. The calculations of these costs are important to take into consideration in the decision-making process. First, we need to account for the direct cost of repainting the intersection. To do our project, we will need to repaint the intersection to help people understand and follow the intended design of the traffic flow. The initial plan is to have 6 different painted crosswalks, with the 4 traditional crosswalks along the edge of the intersection plus the 2 new diagonal crosswalks in the middle of the two intersections. With the new
scramble crosswalk, pedestrians are able to cross from all corners once the lights are red, so it is important to have crosswalks that demonstrate this ability. The average cost of repainting crosswalks is $360 per crosswalk according to the Pedestrian and Bicyclist Information Center website. Given that there would be six crosswalks per intersection and there are two intersections in total, the estimated total cost would sum up to $4,320. This would be a one-time cost incurred at the beginning of the project.

As our main purpose is to increase the flow of traffic, we will also have to reprogram the light so that we can efficiently utilize the new traffic design while balancing the wait time between pedestrians and drivers. The lights will need to be programed so that we will have all the cars and motorbikes stop and yield for pedestrians at given intervals. In addition, we may need to make a decision on the timing of light to best accommodate the volume of pedestrian vs. vehicle traffic at different time during the day. This is not an easy task and thus, will be costly. According to the U.S. Department of Transportation website, in 2005 the cost to reprogram the lights at intersection average to $3,600. Since, the cost on the website is from 2005, we adjusted the cost for inflation using CPI so that it is valued in today’s dollars. Given historic inflation, the expected cost now would be $7,200 to reprogram the lights at the two intersections. Again, this would be a one-time cost incurred at the beginning of the program.

In addition to reprogramming the lights, we will also need additional “No-Right-Turn” signs. The purpose of these signs is to avoid unsafe behavior from past habit. As the vehicle lights turn red, all cars must stop so pedestrians can cross. Under the new project, cars cannot make right turns during the pedestrian phase of the traffic cycle. Based on the information from the Pedestrian and Bicyclist Information center website in 2013, the average cost per each sign is $800 in 2013. Given historic inflation, the average cost now would be approximately $836 each.
There will be 4 signs at each crosswalk, resulting in a grand total of $6,688 for the new signs. These new signs are another one-time cost and will not require discounting.

One important cost that must be incurred with the implementation of the scrambled crosswalk is the creation and distribution of a public information campaign. There are three parts to this public information campaign that will ensure that the entire community has a chance to know about the new project. The first part of the public information campaign will be to set up easels on all corners of both crosswalks under consideration. This part of the public information campaign will not incur any costs, as the easels and printing material are in the City of Fort Collins’ inventory. The second part of the public information campaign is to create an electronic flyer to put on the front page of the of the City of Fort Collins website. This cost is very small relative to the other costs from this project, only $48, since it would only take around 2 hours for a Public Relations Specialist I to make the flyer. A PR Specialist is paid on average $24/hour based on the average salary of $47,907, equating to $48 (Salary.com). The most expensive aspect of the public information campaign would be mailing these flyers to every resident of Fort Collins to ensure the campaign has the necessary reach. In 2016-2017, there were 105,876 recorded occupied living spaces of in Fort Collins (City Docs). Additionally, 500 flyers would cost $90.00 (SG1). With this information, we can extrapolate a total cost of $19,057.68 to mail the flyers to every mailing address in Fort Collins. Adding up all of the costs from the public information campaign we arrive at a total one-time cost of $19,105.68 for a flyer-based public information campaign.

A cost of the project that may be less obvious than some of the other costs discussed above would be the temporary cost of additional police services during the first four weeks of the new programming. Upon the enactment of the scramble crosswalk, there may be an adjustment
period of pedestrians and vehicles getting to know how this system works, even after the public information campaign, as many people have not encountered a crosswalk like this before. The cost to do this would be the wage of two police officers at each intersection, four officers total, during the first four weeks after project implementation. This would lead to a total cost of $13,408. We came up with this number using the average Fort Collins police officer salary, equating to $20.95/hour based on a 40-hour work week, then multiplying the average wage by 40 hours a week, 4 weeks, and lastly 4 police officers (Police Patrol Officer Salary). It is necessary for police officers to be positioned at these crosswalks instead of crossing guards due to the possible risk that this adjustment may induce; having first responders at the scene of these crosswalks will provide safety benefits to all those who are navigating the crosswalks. Additional police presence will only be required at the beginning of the project, and therefore will not require discounting.

One final cost that may be incurred after the implementation of the scramble crosswalk is the environmental cost of cars waiting at the intersections while pedestrians are able to cross the street. The total social cost of CO$_2$ emissions would equate to $1,715.32 to $10,199.20. This was extrapolated by calculating an average of 8 cars being stopped at either intersection with 1,080 light changes a day. This equates to 19,710 hours of waiting annually, which derives 92,715.8 pounds, or 46.36 tons, of CO$_2$ annually. This would be the only recurring cost in the project, which will have to be calculated each year for the next ten years using the present discount value. Using the same discount rate as used for the benefits, 3.5%, environmental costs over the next ten years will range from $15,981 to $95,021.92. This, combined with the other costs discussed above, leads to a total cost of the project of $66,703 to $145,743.62.
Policy Recommendation and Discussion

After extrapolating all the costs and benefits of implementing two scrambled crosswalks on Mountain Avenue and College Avenue and Olive Street and College Avenue, accounting for social benefits and costs, environmental benefits and/or costs, and construction costs, it can be concluded that the project will incur benefits starting in the first year. Many policies that a government implements usually take a few years until a positive net benefit is shown; however, this policy will have benefits covering costs after one year due to the low one-time costs and how far the benefits reach in the target population. In the first year, the benefits range from approximately $123,926.99 to $129,681.34 while the costs range from $52,437 to $60,920.90. Over a 10-year time period, the benefits would range from $1,154,578.85 to $1,208,189.86 and the costs would only range from $66,703 to $145,743.62, since the only recurring cost is the environmental cost of increased carbon dioxide. This illustrates that the benefits not only outweigh the costs in the first year of implementation, but also continue to outdistance costs throughout the life of the project. In addition, recall the unmonetized benefits discussed earlier. While these benefits are not included in the above calculation, it is important to consider them as sources of surplus that will be gained by individuals with standing throughout the life of the project.

As far as surplus distribution considerations are concerned, this policy would not redistribute much income, wealth, or benefits from one class to another as we have seen in some policies implemented to support the city government’s strategic plan. Most of the benefits are concentrated to either people driving their vehicle or the community in general from the reduction in pollution, and most of the costs will be incurred by the government as they are the entity executing the project and there are not many costs that impact the community at large. It can be clearly inferred from this Cost-Benefit Analysis that implementing scramble crosswalks
in Old Town would benefit the community of Fort Collins regarding time saved, possible CO$_2$ emission reduction from car exhaust, and creating a pedestrian friendly environment in the downtown area.
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Robustness Analysis

To test the robustness of our results, we must alter some of the assumptions made in our calculations of both costs and benefits. In this test, we are going to use a best- and worst-case analysis and see if the project is still feasible under each scenario.

For the best-case analysis, we will first assume that a greater number of pedestrians walk both ways on the intersection and will therefore have a longer average wait time before the project is implemented. This change would not affect the average wait time once the project is implemented. By assuming that 15% of pedestrians walk two ways on the intersection, which is seen in other cities that have implemented this project, the net benefits at both intersections are increased but only a small amount, with the value of time change remaining negative (Jaffe, 2012). Specifically, the value of time lost for pedestrians at each intersection would be just under $80,000 annually. This change positive affects the results of the analysis, especially combined with other assumption changes. We could also change the discount rate for our calculations of future benefits and costs of the project. Should we change the 3.5% rate used in our analysis to a 1% discount rate, which would assume that the next best use for the city’s money is relatively unproductive, and account for the previous assumption change regarding pedestrians, the benefits of the project over the next 10 years would range from $1.53 million-$1.6 million. This is a substantial increase in value that entirely offsets the increased costs due to the smaller discount rate, which would put the cost range at roughly $549,000-$638,000. The drastic increases from a changed discount rate illustrate the importance of the discount rate in our analysis. Other means to further increase the net benefits in the best-case scenario analysis would be to change the public information campaign to a cheaper form of information distribution other than flyers, decrease average gas prices
In the worst-case scenario for the scramble crosswalk project, we reversed the assumption changes in from the best-case analysis. By changing our assumption for number of pedestrians crossing both crosswalks to 5% instead of 10%, the value of time wasted due to the project for pedestrians becomes $102,815.24. Combined with a 6% discount rate instead of 3.5%, the benefits for the project are lowered to a range of $845,038.45 to $893,145.32. The change in discount rate also affects our costs, which become a range from $117,499 to $196,908.80. As can be observed, benefits remain significantly higher than costs. Other changes that could be implemented to test the sensitivity of the analysis include increasing the backlog of cars waiting at the intersection during the pedestrian cycle and decreasing the number of cars waiting for pedestrians in order to make a turn, both of which would bring the net benefits closer to zero. We could also increase the number of pedestrians expected to use the intersection, which would increase time spent waiting by pedestrians if we maintain our worst-case assumption of 5% dual crossings. There could also be increased construction costs due to accessibility changes if the city wants to also change how the corners of the intersections are constructed. While unnecessary, the city may want to take this possibility into consideration. Lastly, we could operate under the assumption that drivers will ignore the no-right-turn signs for the pedestrian cycle, which will possibly have legal costs that negate the unmonetized legal benefits discussed in the analysis.

However, it appears to be unlikely that unless significantly negative assumptions were made would costs outweigh benefits over the life of the project. Thus, our recommendation to pursue scramble crosswalks is maintained. To further test our recommendations, we would advise more observations at different times of the day, week, and year on driver wait time, traffic flow, and pedestrian crossings throughout the day. It may also be worth looking in to the
potential benefits to bikers passing through College Ave. (bikes are not allowed on College Ave.). All of these extended studies will help test the robustness of our analysis and establish greater validity for our recommendation.