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Project 1 (First Draft)

Francisco Fonseca Octavio Mesner

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1 Introduction

New York City (NYC) would like to implement a fleet of autonomous vehicles (AV) by 2020 as part of a larger initiative of establishing itself as a world leader in smart city infrastructure. Because of the novel nature of AV technology, there is a considerable amount of uncertainty regarding the impact from its implementation on traffic issues including safety, congestion, energy consumption and environmental impacts. City officials wish to determine the effect of each alternative, while considering uncertainty, on these outcome and optimal strategies moving forward with AV technology within the NYC fleet of vehicles. This study will focus on the alternatives available to implement this technology from AutoMerge, Inc. (AM) specifically in NYC's 40-passenger transit buses. It will compare different alternative strategies by performing a Benefit Cost Analysis (BCA) to assess how these different options impact the general population of NYC, which are the main stakeholders in this issue. Among the factors to be included in the analysis are: safety, energy consumption, air pollution, GHG emissions, weather conditions and traffic flow. Section 2 presents a detailed description of the problem and the alternatives analyzed. Section 4 presents the analysis of each alternative and the results found. In section 5 a sensitivity analysis is performed for some inputs. Section 6 discusses the results of the analyses and section 7 presents the conclusion and recommendations of this study.

2 Problem Description

2.1 Alternatives

Broadly, NYC must consider the following three alternatives.

Alternative 1: Do not implement AV.

> This is the reference alternative. AV is not implemented and the benefits and costs are the ones already incurred to the population. There is relatively little uncertanty associated with this outcome because there is historical data to project the effect of this alternative on outcomes.

Alternative 2: Implement AV in the NYC bus fleet.

In this alternative, the city implements the AV technology in the bus fleet directly (without performing any pilot tests). Because this is an emerging technology, it is unclear how AV will perform in each outcome so uncertainty analysis will help determine the expected value for each outcome using the risk information currently available.

Alternative 3: Perform a pilot test with an amount of n buses before deciding to implement AV.

In this alternative, the city performs a pilot test with a predefined amount of n buses. The pilot test has an associated cost directly proportional to n. The potential benefit of running a pilot study is the additional information gained on risks associated with congestion and other outcomes. It will be necessary to calculate the value of imperfect information for each n for this alternative.

2.2 Benefits, Costs & Uncertainty

Table 1 presents the different direct and indirect costs associated with the implementation of AV technology in NYC bus fleet. Each cost may be slightly different under different circumstances. In our analysis, we assume uncertainty with respect to weather and AM proformance.

Table 1: Costs associated with implementing the AV technology in NYC buses

Capital costs of installing AM system in buses
O & M costs of AM system
Cost of building simulator facility to train drivers
Traffic fatalities
Traffic injuries
Traffic Congestion
Emission of air pollutants
Emission of Greenhouse gases (GHG)
Cost of potential pilot test (*)

(*) only applicable to alternative 2

2.3 Assumptions

1. The number of riders using each mode of transportation will remain stable for all three alternatives.

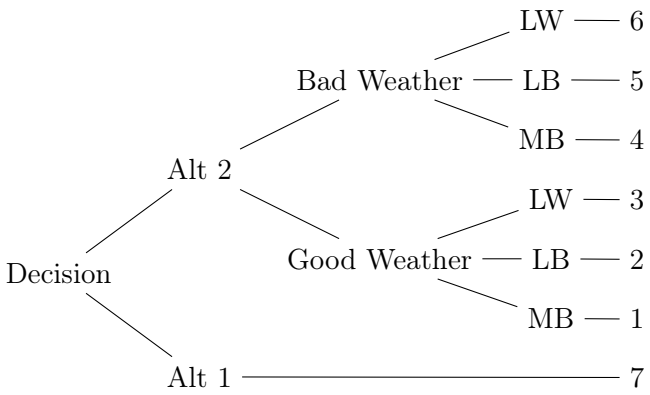

Figure 1: Partial decision tree

2. Changes in congestion will affect motor vehicles (buses, cars, light duty vehicles, and trucks) but not bicycles or walkers.

3. All travel minutes across persons and modes of transportations are worth the same and includes fuel costs, $22 per hour per individual.

4. Weather patterns remain consistent.

5. Any travel time, even fast ones, incurs a time cost. This means that for each alternative, there will be a time cost added which is associated with it.

3 Methods

For this analysis, we use a decision tree with standard expected values to assess alternatives one and two and the value of imperfect information to assess alternative 3. Figure 1 shows our decision tree for the first two alternatives. This same paradigm will be used to compute the expected value of imperfect information.

1. **Congestion.** To calculate congestion costs, we only consider buses, cars, light duty vehicles, and trucks. While walkers and cyclists do experience travel times, we do not believe that they will change with the different alternatives and do not need to be included for comparison purposes. Thus, for any single mode of transportation, we calculate cost as follows:

   $$\text{Cost} = \text{daily person trips} \times \text{average trip hours} \times \text{Cost per hour per individual.}$$

   From our assumptions above, only average trip hours will change under differing alternatives, weather conditions, and AM performance.

2. **Emissions.** Calculating emmissions costs are similar to congestion cost because they depend on average trip hours×daily person trips but each mode of transportation has differing costs associated due to differing emissions.

3. **Fatalities & Injuries.** There are several ways to estimate fatalities and injuries since mean rates are given per trip, exposure time, distance traveled. Since congestion and emissions are already calculated in person/trip-time, we will continue this for fatalities and injuries for consistency.

4. **Capital Costs.** Since the cost of buses will be incurred in all alternatives, we only consider the additional cost for AM which only affects alternatives two and three.

determine these costs

4 Analysis and Results

Write results.

4.1 Alternative 1: Don't Implement AV

4.2 Alternative 2: Pilot test

4.3 Alternative 3: Implement AV

5 Sensitivity Analysis

Write sensitivity analysis.

6 Discussion

Write discussion.

7 Conclusion & Recommendations

Write Conclusion and Recommendations.