Analysis of Car-Sharing and the Effects of Population Size and Affordability on Their Use

Executive Summary

In the next five years, the automobile industry will experience significant changes that will prove to be more influential than the changes that have occurred in the last 50 years. The development of car-sharing companies and programs, as well as population and industry booms has lead to more cities finding the need for more affordable and accessible car-share options. Tasked with creating models to determine percentage of drivers that fall into specific categories, models to determine which car-share option would be best for a given city, and then determine which cities would be best for a car-share company, we developed solutions and found results.

In our first model, we found that people who fall into the age group of 30-49 drive more daily than people who fall into higher and lower age groups. By using the model we created, we were able to find criteria for each of the combinations for the two factors; amount of time spent using the car and the miles driven for low, medium, and high categories. By knowing the sample criteria that these categories could be based off of and the amount of drivers of each age group, we were then able to determine the percentages of drivers in the U.S. that fall into each category.

In our second model we found that whatever mode of car-sharing was cheapest for the population was the one that the majority of car-sharing users would choose. This mode would be most profitable for car-sharing companies and therefore would be the mode they would develop in cities.

In our third model we determined that because new technologies for cars are so costly, it would be unrealistic for people to choose them over char-sharing so self driven cars, and battery operated cars would not affect the model.

I. Introduction

1. Background:

Car-sharing has become commonly used in cities as an alternative to owning a car. Car-sharing involves paying a fee to drive a car for a certain amount of time and returning the car to a designated spot. One type of car sharing which involves driving the car and returning it back to the original spot it was taken from, requires paying per minute, hour or day. Other types of car sharing include one way trips where the car is returned to a spot and an employee drives it back to the original location, one way trips where the car is returned to a designated station, and ownership of a car that is shared by two or more people. These practices are becoming increasingly popular in cities where people can live without a car but might need one occasionally.

2. **Restatement of the Problem:**

In this problem we were asked to decide which method of carsharing would be more efficient for four cities, as well as comparing the growth of this new field with the development of new cars and technologies. The cities were Poughkeepsie, NY; Richmond, VA; Riverside, CA; and Knoxville, TN. The methods of carsharing were the round trip model, one-way car floating model, the one way model, and the fractional ownership model. The model was decided based on the ratio between time and mileage rate that the sharecar company provided for the benefit of the consumer.

3. **Global Assumptions:**

Assumption: College campuses have limited campus parking and student academic offsite traveling and jobs are off campus.

Justification: Most colleges do not allow all students to have their own cars there. Our model also relies on college students needing cars.

Assumption: College students cannot afford to fully own their own personal (not rented) car.

Justification: With living expenses and the cost of college tuition taken into account, most college students can't afford to pay for a car, insurance, and gas.

Assumption: People will be traveling with an average speed from location to location and will be traveling that speed the whole trip.

Justification: A constant speed is needed for our model equation.

Assumption: There will be no poor weather conditions such as rain, snow, ice, or sleet.
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Justification: Our model equation does not account for changes in speed that would result from poor driving conditions.

Assumption: If available, the public will use the easiest method to get from one location to another (bus, walking, and train).

Justification:It is human nature to choose the easiest way to travel if possible.

4. **Variables**
    - Traffic
    - Cost
    - Age Groups
    - Other Modes of Transportation (Public Transportation)

II. Analysis of the Problem and the Model

1. **Who's Driving**

Assumptions

a. People between the ages of 16 and 19, and the ages 75 and above drive the least amount of miles.

Justification: Some people between the ages of 16 and 19 do not have their driver's license, and often do not have to commute to work or college. People above the ages of 75 are driving less than the average American and do not use their car as often as the average adult.

b. People between the ages of 20 and 74 drive more miles.

Justification: People between the ages of 20 and 74 are more often commuting to work, driving more frequently, and have a more pressing need for a car then the other age groups.

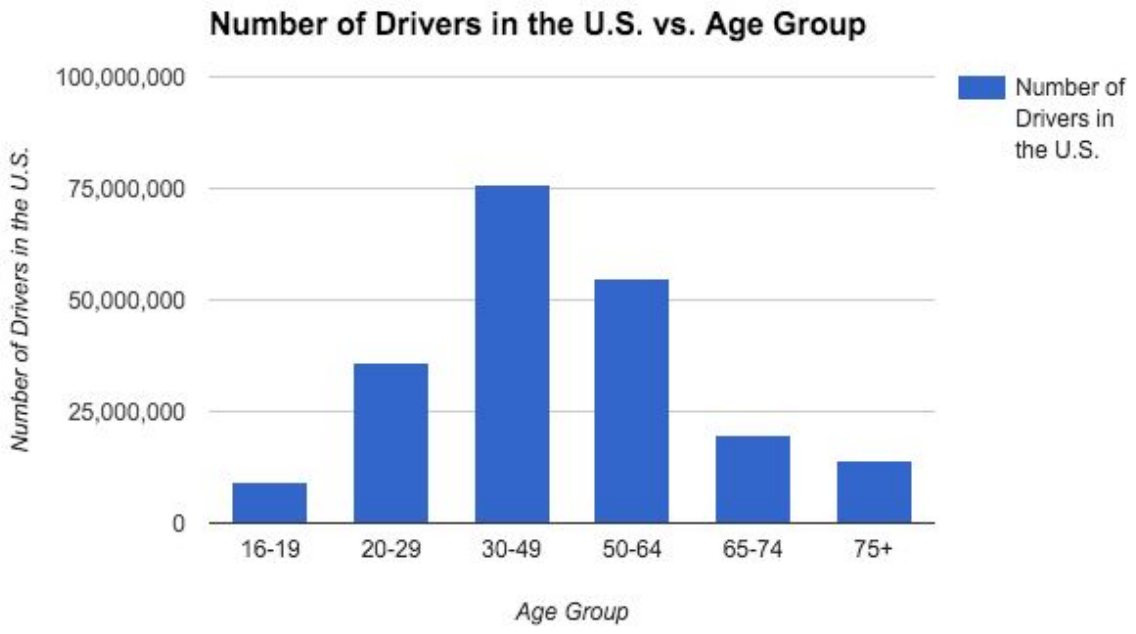
c. People between the ages of 30 to 49 drive the most because they have to work or travel with families.

Justification: Statistics show that people between the ages of 30 and 49 are more likely to use a car and drive on average more miles per day than other age groups due to commuting or family transport.

Approach

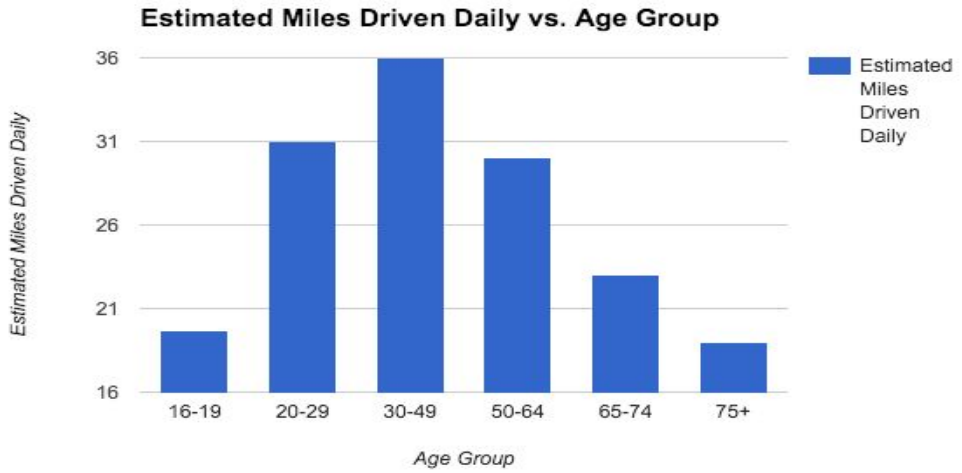
We developed our model based on statistics, percentages, and algebra to determine the amount of people within the different age groups that are licensed drivers, the average daily amount of miles driven, and how this, along with other variables such as traffic, would categorize U.S. drivers into combinations of the two factors present. We developed an equation that can be used to solve for miles traveled, as well as time amount spent using the car, accounting for traffic.

Figure 1. This figure shows the number of drivers in the United States based on age group.



By determining the amount of drivers in each age group, it will be easier to determine the percentage of drivers that fall into each combination criteria .

Figure 2. This figure shows the estimated, on average, miles driven daily by each age group



We used statistics to develop a graph that displayed the estimated miles driven daily by each age group. This, as well as the amount of drivers in each age group, was used to develop criteria for the combinations of each category, which could be refined by the equation and used to determine percentages of U.S. drivers that fall into each characterization.

$$H=\left(\frac{m}{s}\right)+\frac{x}{6}$$

H=Time
M=Distance (in miles)
S=Average speed of the trip
X=Traffic
(6 was used in the denominator because there are 60 minutes in an hour)

For our equation, we are assuming that no negative numbers are used. Direction is not accounted for, therefore distance is being used for the problem, not displacement and speed is being used, not velocity. In this equation model, we discovered a way to solve for time spent traveling using mileage, speed, and factoring in the effect of traffic. By dividing milage by the average speed, we are finding the idealistic time it would take to arrive at the final destination. But in most urban settings, there is always a factor of traffic which can significantly change the trip duration in some circumstances. We added in traffic by putting x over 6. For example, if there is about 20 minutes of traffic, the expression would read 2/6. To convert this expression into hours, you would multiply the the numerator and the denominator by 10. That way, the denominator would represent the 60 minutes in an hour, and the numerator would represent the number of minutes of traffic out of an hour.

2. Zippity Do or Don't?

Assumptions
Assumption: Everyone participating in the carshare can afford it.

Justification: If people could not afford carsharing they would not be using it and wouldn't be using this model.

Assumption: Developed urban city with a population of at least 200,000.

Justification: Car sharing companies will not be as prevalent in smaller cities.

Approach

Based on the population, average distance one travels, and gas prices in each city, we determined which car-sharing business option would be the most efficient in each city. Then based off of the working population and number of college students, we ranked from most likely to least likely for each city - Poughkeepsie, Richmond, Riverside, and Knoxville, if car-sharing companies should establish their services there.

A carsharing company determining which type of car-sharing to implement in a city would choose the option by finding the population of the city that is over 18 represented by *p*. This variable represents only individuals over 18 because anyone younger than that would either not be able to drive, or not be eligible to rent a car from a car-sharing company due to the company's policy. You would then subtract the number of people over 18 in the city with a way of getting around already, *w*. This method can be public transport, walking, biking, or taking a taxi. This would give you *c,* the number of people that would need to use carsharing.

$p - w = c$

From there you would calculate how long the average trip with the shared car is. For one type of round trip carsharing company called Hour Car charges $8.50 per hour. A one way car sharing floating model company called Enterprise $8 an hour for a one way trip. A one way car sharing station model company called Car2Go charges $1 + 41 cents per minute. Lastly, a fractional car sharing model for a Ford Edge Suv costing $25,000 shared by 5 people would cost the people $5,000 each as well as the costs for gas, and insurance. The average cost of gas in the United States is $1.76 and the Ford Edge Suv 2016 gets 21 miles per gallon in cities. If the average trip in a shared car was 30 minutes long then Hour Car would cost $4.50, Enterprise would cost $4.00 , Car2Go would cost $13.30, and a fractionally owned car would be too expensive for the trip and not worth the cost. Because people would naturally want to choose the option that's cheapest, a majority of them would choose Enterprise. Although Enterprise has the cheapest rate, because a majority of people would be choosing that option then it would make the most profit. From the amount of people using each option based on their own personal trip distance needs then the car-sharing company should choose whatever option draws the most customers use because that will generate the most profit.

Another factor that has an effect on the consumers' participation in a car share is the variation in gas price. In each of the previously mentioned cities, there is a wide gap between the gas prices. In a city that has high gas prices, a common consumer may be more inclined to participate in car sharing so they don't have to pay for their own gas. In an area with lower gas prices, the common consumer may not be as intimidated by having to provide for their own vehicle's needs.

All of the previous facts stated about the car-sharing business prove that a car sharing company would have the most success in Riverside, CA compared to Poughkeepsie,

Richmond, and Knoxville. Riverside has the greatest population which means that there are more people to support the business. Of the four cities, Riverside comprises of the most colleges students. Since we assumed that the college students have limited cars allowed on campus and their income is low, they would still need transportation off campus, thus supporting the car-sharing industry. Finally, Riverside has the highest gas prices of the 4 cities. We determined that since Riverside's gas average was higher than the national gas average, then people would be more likely to want to car-share. This is because it would cost more to pay for gas than it would be to pay for a car from a car-share business. We believe that Richmond would come next because it has the second highest population, which is more of a pulling factor than college students, and it has the second lowest gas price of the four cities. Knoxville would be the next because it has the next highest population, and the lowest gas price. Although Poughkeepsie is a big business center, a lot of people in the city rely on the extensive train network that serves as a massive public transport system, and would prefer to use it over a car-sharing option.

Figure 3. This figure shows the population sizes as of the 2010 census of each of the four cities.

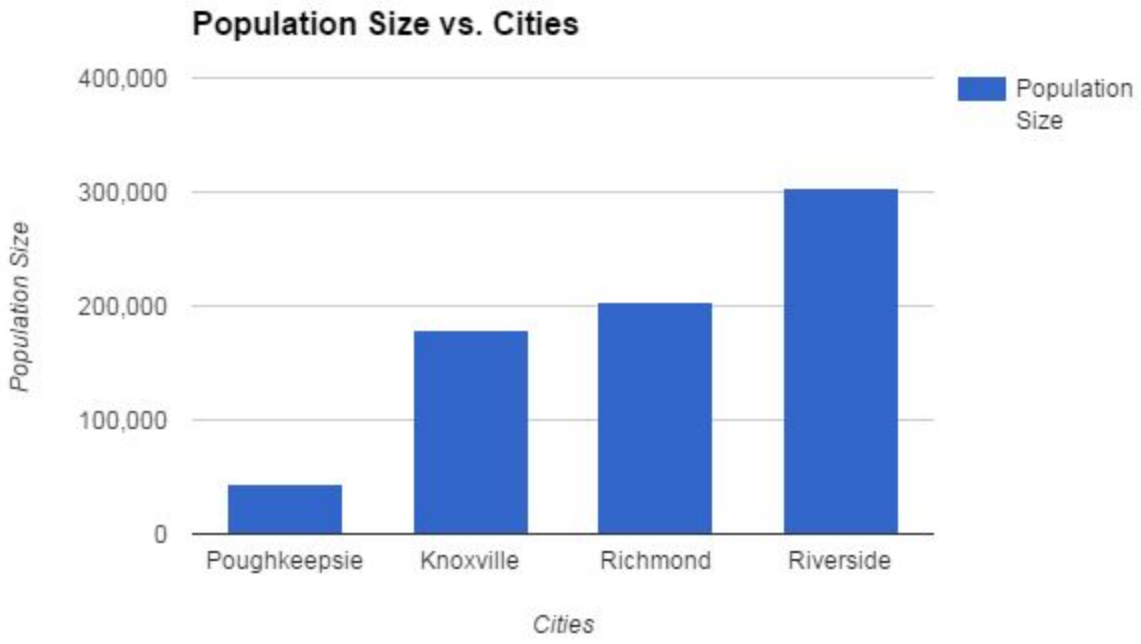
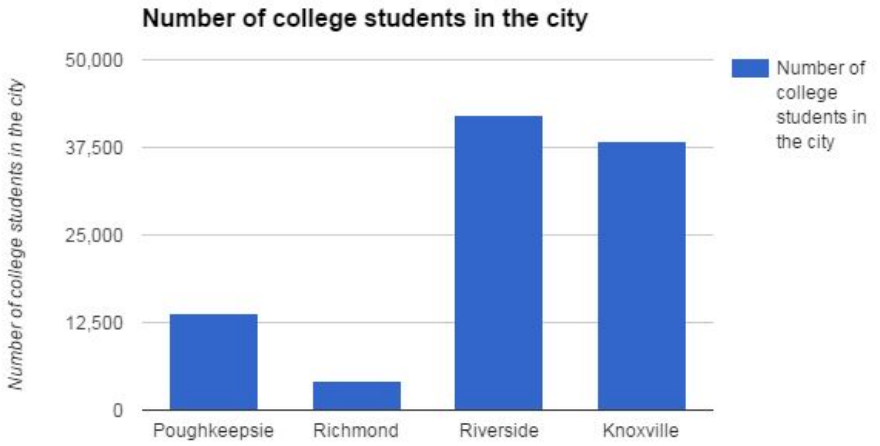


Figure 4. This figure shows the number of students attending a college in the city.



3. Road map to the future

Assumption: Consumers will not be inclined to invest in an alternative if it is more expensive.

Justification: People are more inclined to save money and will usually pick the cheapest option, despite the benefits of the expensive alternative.

Assumption: Businesses will only do what will bring in profit.

Justification: Businesses cannot survive if they are not making money, so they will not invest in more expensive alternatives if consumers do not want to invest in them.

Approach:
Based on affordability and the profit that would come to carsharing companies we determined that the implementation of new technologies will not change our model because Google's self driving cars are estimated to cost $320,000. This is an incredibly high number considering that the average person spends $30,000 on a car. Also, cars that are battery operated cars cost on average $39,200 which is still more than most of the population is willing to pay for a car. It is cheaper for people not to have a car and just occasionally use carsharing companies than it is to buy a self driving car or battery operated car.

Conclusion

After analyzing the factors of how much time and mileage the average American drives and why car-sharing is efficient in the growing cities of Poughkeepsie, Richmond, Riverside, and Knoxville, we determined that Riverside would be the most likely to support car-sharing business. We determined this by using statistics and algebra, as well as national surveys from around the country. For the second model we concluded that whatever method of car-sharing was cheapest for the population would be the one used most often in the area. Determining which method of car sharing was the least expensive was based on the distance the car was driven for. Although the method of car sharing was the least expensive, because so many people would prefer it to the other methods, profit would be gained for the car-sharing company. The company would chose the method based on these findings. For the second part, we used the model to determine in what city a car-sharing company could be the most profitable. Using statistics such as population, gas prices, and college students in the city, we determined that Riverside, California was the best suited for such as business. For the third model we determined that the use of self driving cars and battery operated vehicles would not affect our model in the second part of the problem because the cost of these new technologies is too high for the average person to pay.

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