



Marketing Analytics for Self-Driving Car Customer Segment Identification

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ABSTRACT

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Self-driving car can commute without any human instructions or directions and is capable of analyzing the route as well as the obstacles in its way. Is the 'self-driving car' going to be affordable and expedient for each and every member of the society? By using data analysis techniques like exploratory and causal data analysis, we understand usefulness of self-driving car and how it will impact all age groups. Result of this study indicates the factors that make self-driving car beneficial for people above 15 years of age.

INTRODUCTION

Around 3 million cars were registered in year 2014 in Massachusetts (Guizzo, 2011). Every year, the average sale of cars is increasing by a rate of 8% (Kim *et al.*, 2013). World leading automobile companies like GM, BMW, Mercedes, Ford, Toyota, Volkswagen, Volvo, Nissan, Tesla & many more are manufacturing automobile vehicles while introducing new highly efficient technologies imbedded in their respective cars (Urmson, 2012). When it comes to self-driving cars, car manufacturers who are currently striving to shape this concept into reality are GM, Ford, Toyota, Nissan, Tesla and Daimler AG (Bilger, 2013). Automobile manufacturers are expert in designing and building a car but when it comes to introducing this new feature, the active technology partners are Google, Amazon, Apple & Uber (Urmson, 2014).

Google first introduced self-driving car concept to the world in 2009. Google teamed up with leading car manufacturer Toyota and implemented the technology on Toyota Prius and tested it on freeways in California (Lee *et al.*, 2014). Soon, after 3 years, they began testing the technology with Lexus RX450h. Testing of the self-

driving car soon shifted from the relatively empty freeways of California to busy city streets, where more obstacles are anticipated.

BACKGROUND

In this fast-paced world, transportation has become an important part of a person's daily schedule (Hee Lee *et al.*, 2013). On an average, people spend 28 minutes per day while they are traveling from home to their respective work places. It is important to have an easy and reliable mode of transportation and a personal car is one of the best options available (Chliaoutakis *et al.*, 2002). Many people may prefer public transport to commute, but it limits the accessibility, as the schedule has to be adjusted according to the availability of the public transportation (Yoo *et al.*, 2014). Buying a personal car can benefit in multiple ways – traveling can be flexible, no dependability on others, is safe, saves time and compliments comfort (Sung *et al.*, 2013). If you have a personal car, it will be integrated with multiple safety features like ABS system, airbags, etc. which can be of great benefit compared to the public transport. Irony of this fact is that automobile

technology is responsible for more than a million accidents every year in the United States (Alcala *et al.*, 2016). 90% of these accidents happen because of human error and is a leading cause of death amongst the age group of 3 to 34 years (Brahmbhatt, 2013). In today's world, it is a big challenge in front of automobile manufacturers to increase the safety features in their products (Erlandsson *et al.*, 2005). Self-driving car is the best solution that they can provide.

GENERIC POPULATION AND DISTRIBUTION

After referring the above two graphical representations (Figure 1 and Figure 2), we can infer that population of Massachusetts is constantly increasing year by year in a linear manner. Also, if we observe the age distribution graph (Figure 2), top 3 categories are of the age group 25 to 34 years, 35 to 44 years and 45 to 64 years, which form the earning population. Another important segment of the society

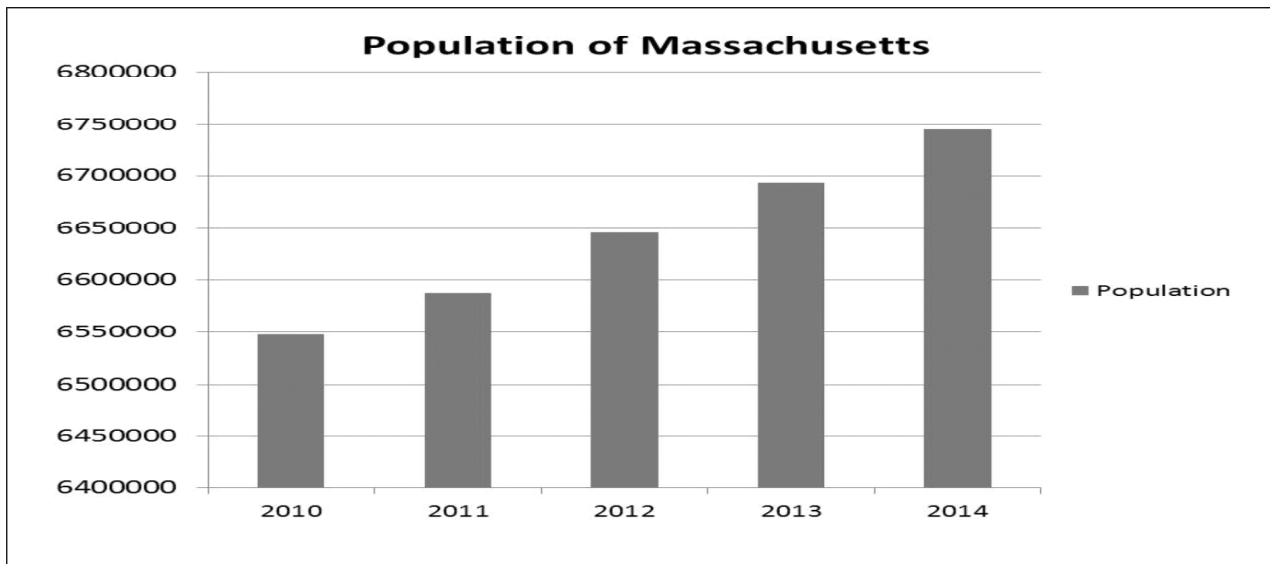


Figure 1: Total population of Massachusetts from year 2010 to 2014. Representation displays a uniform increase in the population count

is of the age group 15 to 24 years. This part of the population is young, enthusiastic and newest addition to the category of driving license holders (Chang, 2008).

If we take a quick look at the segment – 5 to 14 years, this belongs to all those who are in school and

are busy with their primary education. Since they are not authorized to drive, they have to consider public transport or school transport facility or they have to be dependent on their parents / relatives for their commute (Wright *et al.*, 2016). A self-driving car can be of great

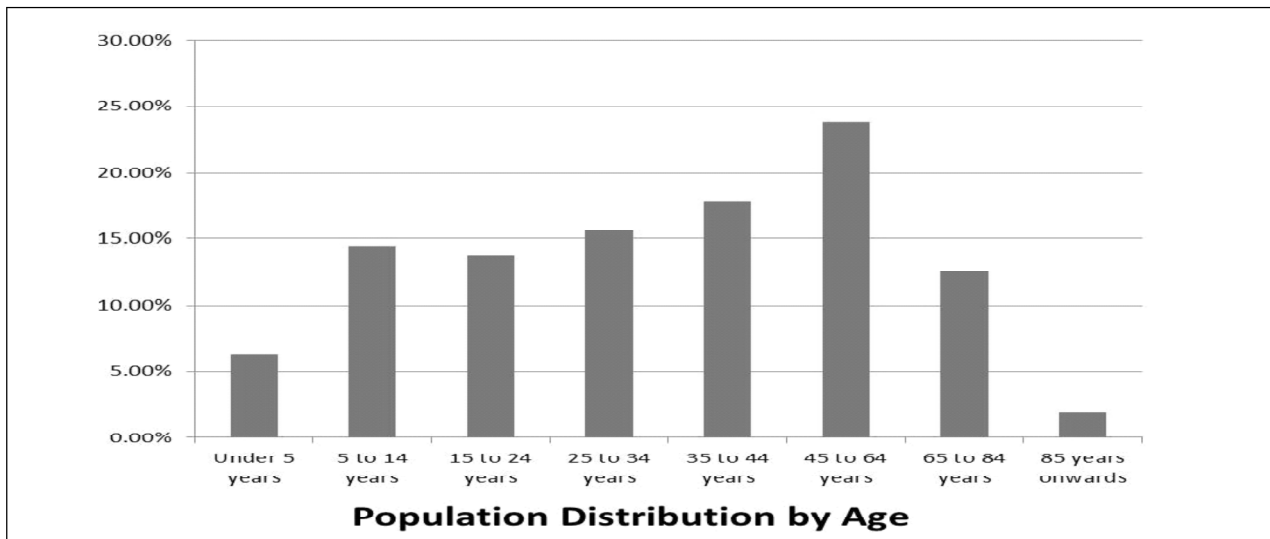


Figure 2: Age - wise population distribution of Massachusetts in year 2014

use here as all parents & relatives, on whom these children are dependent, will get more time for their own professional commute (Fisher, 1997). Indirectly, all those children who are not authorized to drive car, can actually use a car on day-to-day basis without violating law.

Our main agenda of this research is to identify the prospective customer segment for the self-driving car, which is not too far away in future. Very soon this car will be available to the customers and will be seen on the roads of the United States.

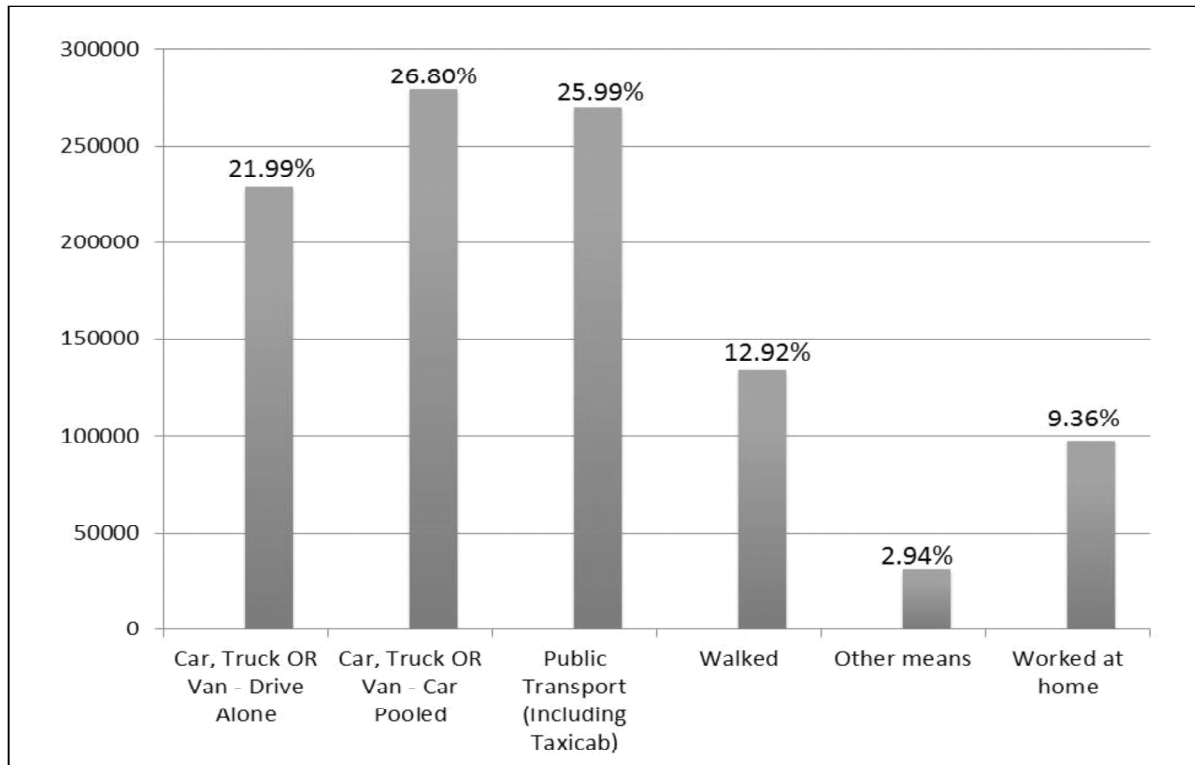


Figure 3: Mode of commutes to work place of Massachusetts in the year 2014

Above-mentioned graphical representation of data (Figure 3) is of the population and the mode of transport they prefer to travel to their work place in Massachusetts. We will concentrate on each of these segments individually later in this report.

In Massachusetts, approximately 22% of commuters drive alone to their work place in their personal car, however, the highest segment count is of 26.80% who prefer taking car-pool. One lucky segment that we can neglect as of now is the 9.36% who work from home and do not need to travel every day or 5 days a week to their respective work place. Approximately 26% people prefer public transport (including Taxicab) to commute to their work place. 12.92% people prefer walking to their work place. Now if we consider each of the segments individually, there are many inferences that we can consider.

- o The highest proportion 26.80% who prefers car-pool, people consider this option because – either they do not own a vehicle, they know how to drive but do not have a driving license,

they don't know how to drive a car, they have a group of colleagues who share common destination and many more. Our sub segments of interest are those people who do not know how to drive and those who know how to drive but do not have a drive license. If we assume a probability of 50% wish to have their own car, implying the logic, approximately 140,000 customers are expected to buy self-driving car only from the car pool group.

- o Let's consider the segment who take up public transport (25.99%) and reasons behind considering this option – either they do not own a vehicle or don't have a driving license or they have a car and license but want to avoid daily traffic, avoiding driving stress and many more. Similar to the above point, if we assume 50% of customers would want to have their own vehicle, we have a segment of approximately 130,000 prospective customers.

- o Considering the above logic and probability of 50%, we have approximately 340,000 prospective customers in Massachusetts. Again, chances of these people buying self-driving car is higher as they all are earning professionals and can afford to buy the car / technology.

Let us consider the possibility of making time productive because of self-driving car. On an average, a person spends 28 minutes in Massachusetts to reach his /her work place from residence. Considering the 2 way journey, a person spends approximately 60 minutes / day traveling for work. Other than for work, reasons for traveling are: shopping, movie, concert and visiting/meeting relatives and friends. Considering the total time span, a person spends approximately 120 minutes / day traveling where either he/she is driving or is being driven by someone. 120 minutes / day indirectly means spending 8.33% of a day which is a significantly considerable amount of time.

Imagine a person is traveling alone in his own car, but instead of him driving, the car is moving on its own and the person is working, attending a phone call or having a power nap. Even though the person is spending same amount of time traveling, he is able to utilize this time in doing some other tasks, making it more productive. A self-driving car will only require the starting point and the destination point to initiate the journey. Once the journey starts, the person can occupy himself with other tasks and our self-driving car will do its job.

STUDYING ACCIDENT DATA

As mentioned earlier in this paper, 90% of the accidents that occur are mainly due to human error. Human error can differ from person to person and the most common human error is – lack of analyzing speed v/s distance v/s time v/s direction all together. In a normal situation, factors that can affect this human ability can be – mental stress, higher age, weak reflex action, uncontrollable speed, influence of alcohol and many more.

It can be easily observed that there is significant difference in count for different age groups. If we concentrate on the age group 15 to 24 years, accidents occurred were least in 2013, which, in comparison, remains more than all other age groups. Second highest is the adjacent age group 25 to 34 years, which again shares the same observation. If we consider only 25 to 34 years, accidents occurred least were in 2011, which remains more, compared to other age groups (here we are not considering age group 15 to 24 years for comparison). Collectively studying Figure (2) and Figure (4), it can be concluded that as the age increases, accidents happening goes on decreasing. In other words, as the maturity and experience level of a person increases, possibility of error happening while driving decreases as they are inversely proportional.

“The State of Massachusetts uses a checklist to detect improper drivers. As a consequence, even though the use of the checklist is not mandatory, the accident rate has decreased.”

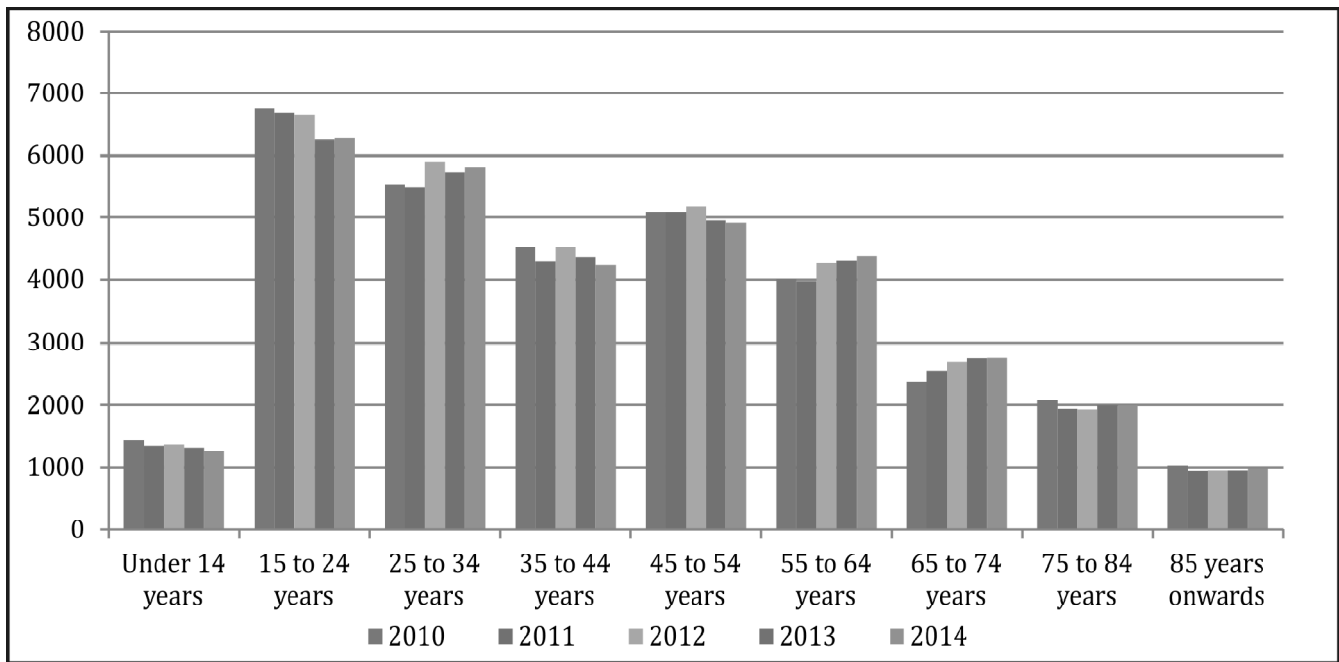


Figure 4: Number of accidents happened in Massachusetts from 2010 to 2014. The above graph represents age wise comparison of accidents over the years 2010 to 2014

ALCOHOL CONSUMPTION

Alcohol consumption remains one of the prime reasons of accidents occurring on the roads of Massachusetts (Wechsler *et al.*, 1969). If we observe the data from 2010 to 2014, the count fluctuates within a range and there is no significant increase or decrease over the years. It is important that the number of accidents because of alcohol consumption be reduced to 0. It seems to be an ideal situation but considering a genuine use of self-driving cars, it is achievable. Self-driving car is basically a technology which will get implemented in a car. Hence, whenever a person passionate about driving wishes to drive manually, car can be shifted to manual mode and when under the influence of alcohol, it can be shifted to self-driving mode.

URBAN VERSUS RURAL

Figure (5) demonstrates a clear comparison of accidents recorded in urban sectors of Massachusetts with the rural sectors of Massachusetts over the years 2010 to 2014. Massachusetts being one of the most urbanized developed states of The United States, it is obvious that the urban sector would dominate over the rural area. Analyzing this data, we can assume that a concept like self-driving car is highly required in urban sectors. We cannot ignore the accidents happening in rural areas but considering a costly, technology embedded self-driving Car, immediate prospective customers can be found in urban areas of Massachusetts.

IMPORTANCE OF TECHNOLOGY

Automobile industry has been booming in The United States since 1960. If we consider the cars that came in the early days, they had manual transmission of gears.

Number of gears varied from car to car but on an average, it was between 4 to 6 transmissions. As years passed by, new technologies got integrated in the cars, like automatic transmission. This particular technology made driving very easy as it relieved drivers / end users from the complexity of handling manual transmission while driving. Also, many more technologies that got imbedded were like reverse sensor systems, GPS, air bags, ABS and many more. We can address a question here - Have all these technologies contributed to add any benefits? Well, if we observe Figure (6), it is observed that the number of motor vehicle accidents is decreasing year by year. Still there persists to be a significant number of accidents happening, but the main reason remains to be human error.

A self-driving car which will be 100% technology driven is expected to bring this proportion of accidents close to 0. Even then, there will be few factors that will leave room for occurrence of accidents with self-driving cars.

AGE GROUP OF 65 YEARS AND ABOVE

Of the total population of Massachusetts, approximately 13% of the people are above 65 years of age. As we have discussed earlier, one of the important reasons for accidents to occur is human error. When a person is driving a car, the most common human errors are the incapacity of pushing the brake on time and the lower judgment ability of the driver apply brakes on time, not able to get precise judgment of the vehicle's dimension and reverse gear judgment. It is a well-known fact that as age increases beyond 60 years, the probability of losing control and misjudgment increases. However, the experience gained over the years of driving almost eliminates the possibility of occurrence

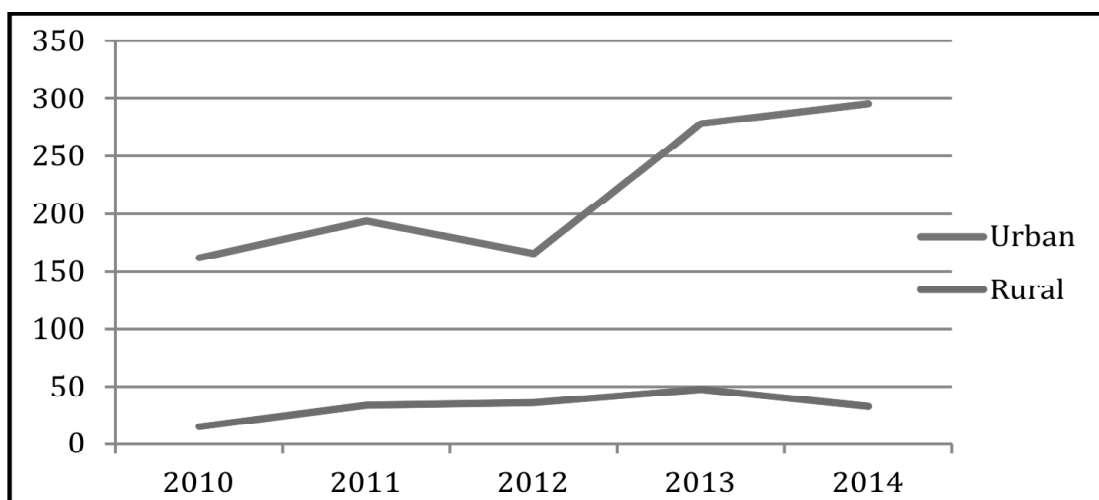


Figure 5: Accidents occurred in Massachusetts during year 2010 to 2014. The above graph represents comparison of accidents happening on roads of urban areas and rural areas of Massachusetts

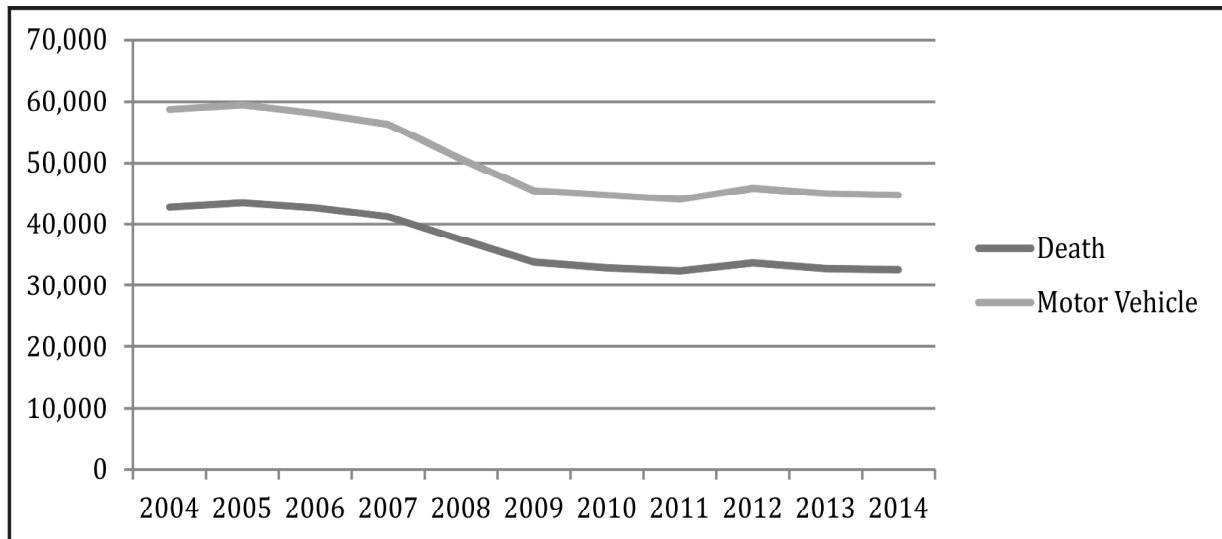


Figure 6: Number of deaths happened from 2004 to 2014 in The United States. The graph above represents deaths happened in road accidents only



Figure 7: Numbers of drivers killed in road accidents. All the drivers were under influence of alcohol with BAC ≥ 0.08

of mistakes that may lead to accidents. Hence the ratio of accidents from this age group is relatively less.

A self-driving car, which we are projecting, is capable of avoiding the remaining circumstances where people belonging to this age group may happen to end up in an accident. This car will move on a particular street only with the permitted speed limit and also it will control the speed as per the obstacles present in 360° arc. Chances of self-driving car bypassing an instruction is negligible because, it will follow the instruction code compiled in the system and no other factors. Hence, as long as the code is capable enough to handle all scenarios, chances of accidents occurring

due to human error are negligible. Analyzing all the above points, we can conclude that the age group above 65 years is one of the prime customer segments of self-driving car.

DISABILITY

People, who are physically disabled, also deserve to be given a valuable attention in our report study. These are the people who cannot use a vehicle for their commute and have to be dependent on others for any of their travelling needs. In the year 2014, 'Annual Disability Statistics Compendium' included a Disability Statistics Annual Report for 2014. Unfortunately, we

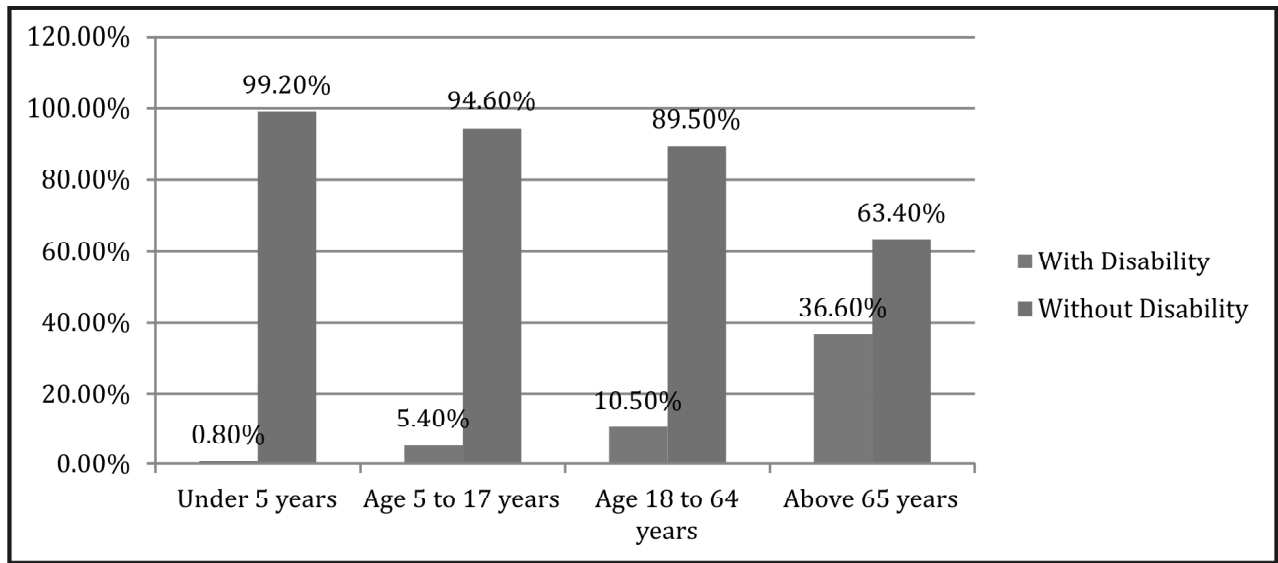


Figure 8: Population distribution with and without disability. The comparison is an age wise distribution of people in complete United States for the year 2014

do not have a data for Massachusetts but we will review the ideology referring to the data of The United States. Refer figure 8 for the age group distribution of the disabled people.

As we can see in the above graph, the total population is categorized in 4 age groups – under 5 years, 5 to 17 years, 18 to 64 years and above 65 years. Even though these people are disabled, they have some abilities stronger than the abled people. With the help of these abilities, they can earn their living and for this, they need a reliable mode of transportation. A self-driving car which can work on voice command

OR written / typed command, is of great assistance to this segment of people.

Referring to the Figure (10), it is clear that physical disability is one of the important reasons of poverty. After a cumulative study of all the diagrams in the Disability section, we can conclude that self-driving car is a very important medium for disabled people but considering the cost factor, it is difficult to convert it into reality. Hence, disabled people even after having huge requirement of self-driving car, is not a profitable customer segment.

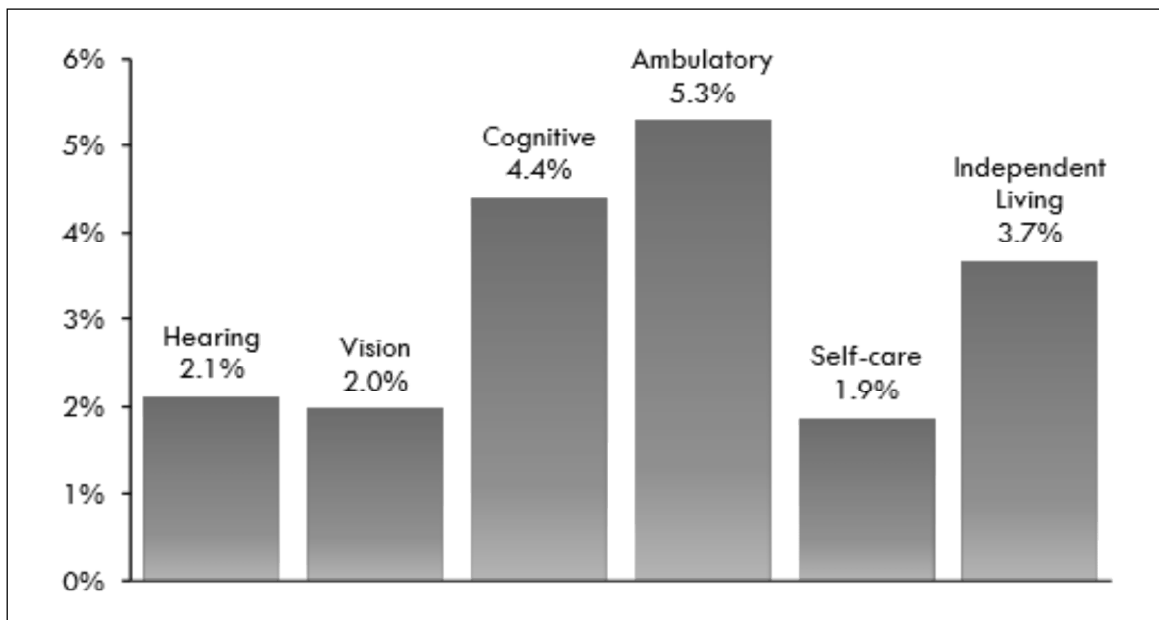


Figure 9: Types of disabilities within the age group 18 to 64 years. [13]

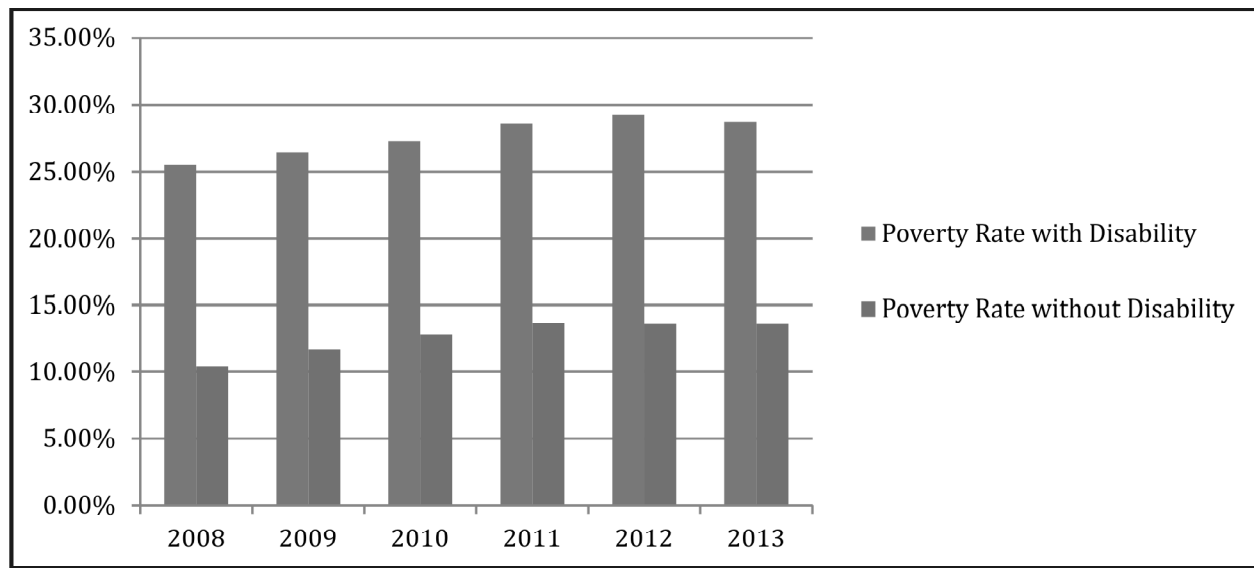


Figure 10: Poverty distribution of The United States considering disability as a factor

AUTO – PARKING FEATURE

It is very difficult to find a place to park your car during the busy working hours. If a person does not have a pre-arranged parking space for his / her car, it is very difficult to find a reliable parking space and avoid getting a ticket. A self-driving car can be of great use to professionals who wish to save time on commute and do not want to waste time searching for a parking space.

Once the commuter gets down at the destination, all he/she has to do is to shift the self-driving car to parking mode and the car will search for a legit, valid parking space on its own as per the co-ordinates it gets from the system.

IMPACT ON INSURANCE COMPANIES

The number of vehicles sold in Massachusetts increases year after year. All of them want to insure it so that they are compensated in an event of an accident or a theft. On an average, insurance premium for each vehicle is approximately \$750. Insurance companies are not liable to pay the insurance if an accident happens because of vehicle malfunctioning. It is the manufacturer who is considered responsible for the accident and is liable to take care of the compensation. It is important to have one's vehicle insured as the cost of repair is very high if at all any accident occurs.

Considering a concept of self-driving car, there won't be any human participation in the functioning of the car. Chances of accident occurring will be almost negligible. There will then be accident occurrences mainly because of a system defect / bug, which will be

a manufacturing defect and insurance companies will not be liable to cover for the loss. Hence, auto-insurance companies will have a huge profit projection by bringing self-driving cars to reality.

From a consumer's point of view, he / she will pay a certain amount only because there are returns expected from it. Even after being insured, the customer will not get any insurance claim benefit and hence it is obvious that number of customers will decrease for auto-insurance companies. In order to retain customers and acquire new customers, insurance companies will have to come up with new products with very less premiums.

'Metromile' executed one smart campaign recently where customers are needed to pay insurance premium depending on the distance they drive. With such a flexible product, customer can save up to \$500 annually. They came up with this type of strategy to handle one of the most common scenarios – Be convenient to customers who drive very less.

All the auto-insurance companies will have to come up with customizable products to retain old customers as well as attract new ones. Irrespective of customers buying self-driving car, customers will get the benefit, as insurance companies will bring down the premium costs to accommodate the varied needs of the automobile domain.

SHOULD THE SELF-DRIVING CAR HAVE AN OPTION OF MANUAL DRIVING?

When we say 'self-driving car', the very first thought that comes to our mind is a car that will move on its own from source location to destination location.

Having thought of this, there are two possibilities of a self-driving car – 1) Car having a system installed in it. This car will have a steering wheel, accelerator and brake pedals. 2) Car without any steering wheel, accelerator and brake pedals. Does it really matter? Let's see some inferences below.

If we consider self-driving car without any steering wheel, accelerator and brake pedals, there will be absolutely no possibility of human taking over the control of the vehicle in any circumstance. It will be important that the system should be 100% bug free. Also, this type of car will be attracted to people who do not know driving and do not intend to learn in future. Another set of customers who will be comfortable with such model is those not able to drive either because of some disability or older age. Dependability on the car will become 100%. However, such car model will strongly repel those who like to drive.

Now, let's consider a normal car with steering wheel, accelerator and brake pedal with a switch allowing shifting from manual mode to self-driving mode. A person can take over complete control on these types of cars as and when needed. If a person wishes to drive the car, he / she will have to switch to manual mode. This type of feature is definitely going to attract all those who like to drive on their own sometimes. This type of model will also come in handy in case of a system failure where one or more features of the self-driving technology fail to perform. In such a case, the car can still be used in the manual mode and will not lie in the garage until it can be sent for repair.

In Figure 4 we have already seen that age group 15 to 24 years and 25 to 34 years are two age groups having the highest number of accidents occurring. Also, we know that alcohol consumption remains the prime reason of accidents occurring. Hence, combining the logic, we can say that between age group 15 to 34 years, maximum accidents happen because of alcohol consumption. Young people prefer driving car on their own and hence won't go for a self-driving car without steering wheel, accelerator and brake pedals. So, whenever a person is under the influence of alcohol, he/she can shift the driving mode from manual to self-driving mode. With this one can reach the destination safe and secured, ultimately resulting into less accidents occurring because of alcohol.

DISADVANTAGES

Cyber Security

Self-driving car is a technology designed on the foundation of multiple data sets and algorithms. Car will follow the algorithms embedded into the system.

As the car is going to be very advanced, it is equally vulnerable to threats across the globe. The self-driving car will be synchronized with the user's smart-phone as well as the global positioning system.

Hackers and intruders into the system can find a way to make changes into the algorithm, which can misguide the directions of the route. Because of such intrusions, the car can become a big threat as it will not work as per its ideal usage and can cause serious threat to its users.

Since the user's self-driving car will be connected to the smartphone as well as multiple systems and servers and his/her personal data will be linked to the system. An intruder will have complete access to this very sensitive information. Personal details like the daily travel route and schedule may no longer remain secured. Consider a situation where the user has left his/her residence in his/her self-driving car, an intruder can come to know about this and can break into the residence for a theft or plan of any other unlawful activity in their absence. Hence, it is very important that the system should be highly secured, encrypted and encapsulated.

Cost Factor

One of the main hurdles for a successful market of a self-driving car is the cost factor it involves. Developing a full-fledged car with this intense technology will cost millions of dollars. It is known that Google alone invests minimum of \$200,000 in a single year on the self-driving car project. Once the self-driving car is launched for consumers, it will cost much more than the cars that are currently available in the market.

Out of all prospective customer segments we discussed in the previous sections, not everyone will be able to afford the vehicle and the technology.

One of the biggest challenges is to overcome human error, which increases with age. On the contrary, an individual who is above 65 years of age is a retired individual and is non-earning. In such a situation, it is difficult for such a person to invest his / her lifelong savings on a costlier car when there is a cheaper option available.

Job Loss

Since the main task of driving will be taken over by the car itself, there will be a great drop in the jobs available for professional drivers. Some of the common jobs are drivers to corporates, Uber / taxi drivers, courier service vehicles and many more.

Even though drivers might get replaced, truck drivers might not get replaced with the self-driving car,

as a lot of mental decision making skills are required when transportation is done in huge vehicles like trucks at a greater distance.

Loss in Transportation Revenue

From the point of view of the Government of The United States of America, one of the revenue sections is from the Transportation Department. Fine collected because of speeding or parking tickets adds to some amount in the Government account.

There will be a significant drop in the need for monitoring law enforcement in the transportation department because of very less accidents and no or minimal law breach.

Drastic change in resident plan

Students or working professionals try to live close to their educational institution or work place to avoid the stress of transportation. For this reason, many are ready to compromise on the cost factor and they invest more on residential properties.

Because of self-driving car, people will not be having driving or travel stress because of which they will be ready to shift to suburbs from cities.

FUTURE RESEARCH DIRECTIONS

Google introduced a self-driving car prototype in 2009. For the past seven years, multiple car manufacturers and technology providers have taken up the challenge to bring self-driving car into reality. As the car is slowly and gradually reaching state of perfection, simultaneous task for all these manufacturers is to identify the prospective customer segment to achieve the dominating position in the market.

The raw statistical data studied and accumulated for this report and co-relation between different data sets will have to be linked concluding the relation between them. Once the relation is defined, we can come up with the equation and can build a predictive model of occurrences – normal car v/s self-driving car.

Going forward, if at all there befits a tie-up between insurance companies and self-driving car technology vendors, many new customer and pocket-friendly products can be introduced. Consider a user who uses a particular route to reach his work place and back home. Self-driving car will record the daily track route and the co-ordinates. On the other side, same system will be linked to the GPS with street safety factor. If the user is traveling every day from highly unsafe street (accident prone), insurance companies know that this particular customer is a highly prospective customer. Insurance company can come up with special insurance

plan with unique policy plans that fits the requirement of such a customer. As we reconnoitered in the disadvantages section, self-driving car can create a drastic impact on the insurance companies and its profit margins. But the same project can, eventually, turn into a highly profitable one if the data is utilized to create relatively useful products.

CONCLUSION

After studying the complete article, we can conclude the following:

- A self-driving car can be of great use to all parents & relatives, on whom their children are dependent. They will get more time for their own professional commute. Indirectly, all those children who are not authorized to drive car, can independently use a car on day to day basis, without violating law.
- Of all the people commuting to their work place not in their own car, approximately 340,000 can be prospective customer segments for self-driving car in Massachusetts.
- People who travel to their work place daily in their own car is also a prospective customer segment as they can utilize the travel time doing some productive work instead of having to engage themselves in driving.
- Considering the factors like weak reflexes, disabilities and weak health conditions, age group above 65 years becomes another prime customer segment.
- Disability being most important reason for poverty, majority of the people having disability cannot afford the highly efficient technology of self-driving car.
- Self-driving car is going to have an intense impact on the auto-insurance companies with respect to the revenue in a positive way.
- Out of the two beliefs, self-driving car with and without manual driving option, it is preferred that the car should have the dual mode option.
- Self-driving car has direct impact on various industries like transportation, medical, real estate, automobile and information technology.

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KEY TERMS AND DEFINITION

American Community Survey – The American Community Survey is a large, continuous demographic survey conducted by the U.S. Census Bureau that provides accurate and up-to-date profiles of America's communities every year.

Cognitive Disability – Individual having difficulty concentrating, remembering or making decision.

Ambulatory Disability – Individual having serious difficulty in walking or climbing stairs.