Autonomous Vehicles and Pedestrians: A Competition for the Future

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In the early 1960s, an important, impactful and historical feud swept the streets of Manhattan. This dispute was between Robert Moses, a master builder and urban planner, and Jane Jacobs, a journalist who provided big opposition to Moses plans. Moses planned a lane elevated highway which would result in the destruction of numerous buildings and displacement of parents, children and businesses. Moses was said to highly favor automobiles over people which infuriated Jacobs and the city dwellers. Moses once said, “Sitting without traffic is a ghost town.” This plan and mindset of Moses was the fuel to the fire for Jacobs and led to the two adversaries, “circling around each other like tigers in a cage” (Random House, 2009). This feud was the beginning of an important exchange between big, wealthy urban planners and the people living in these cities that are being affected by their decisions. In the end Jacobs and the people had such a vital impact, through protests and open criticisms, that Moses scrapped the plans and future cities began recognizing the importance of listening to the people. This fight for the way future cities were designed and a better representation for the people is a precursor for the present-day fight for autonomous vehicles in future city landscapes and design.

In the last couple of years, a topic in the area of science and technology that always gets some attention is the future of autonomous vehicles and where the United States stands with the technology. The possibilities of AV technology are endless and could revolutionize cities all across the world. Countries all across the world, such as The Netherlands and China, are attempting to get into the action by working with the technology and bringing it to their respective countries. There is a lot to be excited about when it comes to AVs because of the many benefits that will result from the technology. The benefits include humans not having to

focus on the road while riding, being able to go somewhere even when intoxicated and the number of accidents possibly being reduced significantly. In addition to these benefits, there is always the natural excitement that comes with new technology, such as when a new iPhone comes out or a new app hits the market. Many traffic and vehicle organizations have also started putting out statements on the possibility of AVs being implemented. The National Highway Traffic Safety Administration stated that, "The continuing evolution of automotive technology aims to deliver even greater safety benefits and – one day – deliver automated driving systems (ADS) that can handle the whole task of driving when we don't want to or can't do it ourselves." (NHTSA, 2020) What is important to note in that statement is the terms "aims" and "one day" because it is those terms that show the uncertainty of AVs. It is this doubt that has led to the competition between AV promoter groups and pedestrian advocacies over the future place that AVs have in city design, mobility and infrastructure.

On one side of the debate is AV promotors fighting for a city full of their technology and, in extreme terms, a city that does not contain any non-autonomous vehicles. Their goal is to have streets designed with fewer pedestrian space and more lanes for the increase in AV vehicles. The goal of the promotors is to have public transit and mobility become fully autonomous because they believe that their technology is the most efficient and safest form of mobility for the future. The idea for the future is similar to that of Robert Moses and his mindset of automobile are more important than pedestrians. Similar to Moses, the promotors are attempting to implement their ideas for the future without citizen participation. Just like Moses idea for the 10 lane expressway, AV promotors have ideas for complete AV transportation and city designed to support the new technology. On the other side is the pedestrians who are fighting for a city with more sidewalks, great spaced to maneuver and better safety regulations and laws to meet their needs. They desire

more bike lines to further the separation from cars to the sidewalks. The pedestrian advocacies and groups are similar to Jane Jacobs and her desire to have an influence on city design by taking away some of the power of urban planners such as Robert Moses. Pedestrians are working to gain more regulations and safety measures in order to keep themselves safe. The rich AV promotors are seeking to exert their influence on future cities and pedestrians are fighting for their place in those cities just like Jacobs did against Moses. This fight is an extreme and present-day version of the fight between Moses and Jacobs.

In this fight, the agenda of AV promoter groups is to spread the benefits and positive aspects of AVs to the public. Their goal is to share their knowledge of the technology and all the possibilities that will come with it to the people in an effort to encourage them to buy AVs when they become available in the future. A company that is making efforts toward building a future with AV technology is Tesla. An example of someone who is a major promoter of AV technology is Elon Musk. Musk once said, “Self-driving cars are the natural extension of active safety and obviously something we should do” (Musk, 2019). Musk is a reflection of the strategies that AV promoters and promoter groups are using to influence more and more individuals to buy AVs when they become available. Their intentions are to grow the knowledge base around them and in turn heighten their influence on the future city. Even outside of AV promoter groups big tech company heads are adding to the influence. Mark Zuckerberg came out and said, “If you recognize that self-driving cars are going to prevent car accidents, AI will be responsible for reducing one of the leading causes of death in the world.” (Zuckerberg, 2019). On the other side, it is pedestrian advocacies that are working to show the dangers of AVs and help get the needs of pedestrians all across the United States met. Many pedestrian groups feel that states are not doing a good enough job of protecting pedestrians. These groups worry that

AVs will eventually take over society and pedestrian rights and safety will diminish as a result. One case that often gets brought up by these groups came from Waymo which is an AV technology group. They reported that 18 of their robo-taxi service vehicles were involved in an accident with pedestrians (Waymo, 2020). It is concerns like these and the uncertainty of changes that could result from AVs having a major role in the future city that fuel the fire of these pedestrian advocacy groups such as PEDS, Walk Denver, etc. Outside of these groups are also concerned families who worry about the safety of their kids when they are not in control which would be the case with AV technology. The two sides of this competition that are being looked at through future transportation implications, future mobility and design and space use. The different possibilities and safety issues of AVs are what has led to such a division between these groups.

This fight is for our own future of American cities just like Jacobs became an adversary in order to affect change in her own future. There many social and ethical aspects that make this such a tough fight. The choice of a future city designed for AVs creates ethical issues of how do you regulate them, who is responsible for accident and in the case of multiple obstacles what/who does the AV choose to collide with. Significant research has been done to analyze how the code is taught react but with the technology not being ready for implementation, there is no telling what the results will be. On the contrary, social benefits could arise as people will be more comfortable while in the car and some studies have shown that the cars will be more compatible for work and leisure activities. In addition, for 50 years urban planners have failed to engage with citizens on designs that would immediately impact them. It is because of this that there is such a desire for the two sides to compete for their perspective on the new American city.

Problem Statement and Guiding Questions

With AVs being so complex and still a work in progress, it is easy to see why there is so much debate between AV promoters and pedestrian groups. The groups have different feelings about what the government plans to do, how transportation administrations will design future cities in the presence of AVs and what form of mobility should be given the biggest priority. The actors involved on one side are AV promotor companies such as Waymo, Voyage and Cruise. Their vision is for an American city full of their technology and designed with parking, transportation, mobility and street design fit for AVs. The future of city dwellers and for anyone visiting cities and the impact of AV technology on their future is the focus of this research. I aim to analyze the concerns of both sides and examine how they are attempting to influence people living in and visiting cities of their concerns. The impact of this competition extremely important to the American city because the lives of people who live in cities will be significantly influenced by changes to street design, means of transportation and standard mobility. My research will investigate the competition by looking at two different dimensions: 1) local and state advocacies; 2) Government and federal level organizations.

This thesis will be guided by the following research questions. Firstly, what exactly are both sides of the issue doing to expand their influence? Secondly, what does a future city look like through the eyes of both pedestrians and AV promoters? Lastly, what are the main agendas for both sides of the competition?

In this thesis I am using SCOTS to analyze how both sides of the competition view the "best" American city and how human actions have shaped AV technology. The stakeholders on one side are the people working on and promoting the technology. These stakeholders envision the best American city to revolve around AVs because their life's work involve getting AVs into

society. They envision public transit, transportation sharing services and everyday vehicles to all be AVs and to have urban planning designs better accommodate the new technology. They interpret what is the best future city based on what will get them the most money. On the other side are pedestrians, city dwellers, and public transit users who are fighting for their place in their vision of an American city. Their vision of a city involves better and more walkways for pedestrians in order to keep them safe from vehicle traffic. In addition, pedestrian advocacies seek more regulations protecting them from vehicles and better access across bridges, busy streets, etc. Through this analysis, I seek to uncover how these stakeholders are striving toward their idea for a future American city.

Review of Literature

A majority of studies done on this topic have either studied pedestrian advocacies and their perception or AV promotors and their beliefs. Not much research has been done to combine the two and deeply analyze how the two sides are competing for future city space. One study done by Dutta and Fitzpatrick took a look at autonomous vehicles through the eyes of non-motorists such as pedestrians (Dutta and Fitzpatrick, 2020). In their study, Dutta and Fitzpatrick studied whether or not pedestrians with prior experience with AVs would have an altered perception of AVs because of those experiences. From this they concluded that the pedestrians with previous experience considered them to be safer than human drivers and could now recognize the safety potential of AVs. They also noted that there is a need to regulate these technologies and make sure they are ready to be adopted into the real-world. In addition, the duo brought about an important point in regards to the recent increase in walkers and bikers because of health benefits and environmental protection. It is because of this fact that the amount of vehicle and pedestrian related accidents and deaths has increased in recent years. Another related

study done on this issue analyzed the need for policies and interventions for pedestrians especially if AVs get implemented into society (Job, 2020). Job did an analysis on how pedestrians are in a struggle for a better standing in society. He also took a look at the pedestrian detection system in AVs as it stands now. He discovered that the system can sometimes miss pedestrians which takes away from the possible safety benefits. He also pointed out that the first fatality involving AVs was a pedestrian. These points brought up by Job are many of the same concerns that pedestrians advocacies are bringing up in their fight against AVs in society.

Similar literature has been written on where the technology stands now and why it will be important in the future. Forrest and Kanka, performed a study on the role AVs could play in a future society (Forrest and Kanka, 2020). One thing they introduced is all of the things that AVs can do and will do for individuals when they get implemented. They listed things such as saving fuel economy, shipping, taxis and time saving. These are many of the points that are being brought up by AV promotors when they discuss the need for AVs. There study is also similar to the agenda expressed by av promotors because they showed that they understand the technology by creating a representation of how AVs would work for people to understand. They explain the connection between the sensors, logic processing unit and the mechanical control systems. Helping individuals to understand how the technology would work is one of the goals of AV promotor groups.

Other countries have looked at the safety concerns and how will regulate AVs when they get implemented into society. China has already planned new rules for AVs at the local level even though there has been no action at the highest level of government. China is suggesting that companies be required to gather data and a person must be seated in the drivers seat (Reuters, 2021). Although this is just the start, it is a good example of how other countries are considering

how to counteract safety concerns brought about by pedestrians and city dwellers. In addition to China, The Netherlands has also taken advanced action with AVs and keeping people safe from them. According to the KPMG, the Netherlands ranks first overall in the Autonomous Vehicles Readiness Index. The Netherlands specifically ranked first in their infrastructure readiness which is something that these groups are competing to influence (Canis, 2019). These countries provide context to how important this competition is in the United States.

STS Framework

The research uses social construction of technology to address how society and culture have led to a need for AV technology. Social construction of technology states that technology does not determine human action but instead human action shapes technology. The four components of SCOT are flexibility, relevant social groups, closure and wider context. They concept of SCOT can be applied to the design, development and transformation of technology.

The relevant social groups on one side are the AV promoters and AV employees who are advocating for their advancement. On the other side are pedestrian advocacies, parents with children, bikers, public transportation drivers and rideshare drivers. In addition, passengers of these services are another social group with a stake in the competition. One aspect of SCOT related to AV technology is that social groups frequently go to bars to drink alcohol they need a safe way to get home that is not costing them more money. One way social groups have transformed the possible use of AVs is to have them to save money on transportation for groups who go out to drink. Engineers design the technology and going out from there the groups seeking the technology influence its possible uses. Whether its using them for taxis, saving gas, etc. there are different groups of people that will use the technology differently. As it becomes more and more socially acceptable to go out a drink, social groups have shaped AVs as a major

solution to the drunk driving problem. Within this problem are differences in the two groups and how they both view and shape the technology differently. This aligns perfectly with the goal of this thesis in that different groups are being analyzed through their viewpoints of AVs. SCOT reflects this in that it looks at how different groups shapes the technology. Through this understand and connection to SCOT, this paper will be better suited to answer the research questions.

Method

A qualitative research method will be used to answer the previously brought up questions as the data for both sides of the debate will be collected through document analysis with a variety of journals and group websites or media releases. The first strategy used was to look at local advocacy groups and AV promotor groups and things that they discussed, shared or expressed. Different connections between the group's ideologies helped the understanding of the shared values that the groups had. Another aspect of this research is the role that the government plays. The next approach was to look at groups at the federal level such as federal agencies and safety administrations. Some concerns brought at the local level were about the role that the government would play in this issue, so looking at what governmental organizations had to say on the issue would be beneficial to answers the research questions. Another method that was used was looking at survey data on how people felt about AVs and getting their feelings on the issue. This helped bring about more concerns of the people which led to more possible points of discussion that advocacy groups and promotor groups were possibly discussing. Once all of the data is collected, a quantitative analysis will be completed in order to fully analyze the two sides of the debate and answer questions brought about by this competition.

Data Analysis

The continued development of autonomous vehicles and their implementation into society has led to a major rift and debate between AV promotor companies and pedestrian advocacies. AV promotors are fighting to expand the influence of autonomous vehicles and strike down any possible issues that may result from them being implemented into society. Pedestrian advocacies are bringing about the issues and high costs that AV's will cause in their fight to protect pedestrians and expand their influence in society. Compounded this issue is that pedestrian deaths are already issue even with human drivers. In 2018, over 6000 pedestrians died from cars. This number is staggering and is one of the main fuels to the fire that are running through pedestrian advocacy groups. One aspect of this argument is the desire for both sides to claim more future city space. In 2020, only the state of California made significant strides toward supporting walking (Safe Routes To School Program Report Cards). Pedestrian advocacies have been working to create more inclusion and increase pedestrian mobility all across America. Achieving more of a claim of future city space is one major goal of all these groups. America Walks, a major pedestrian advocacy group that is anti- autonomous vehicle, has four main goals and those are, "advancing the national walking movement, empowering state and local coalitions to be more effective, ensure inclusion of walking in national policy agenda and developing organizational capacity and identity."

A case study was done in the city of Richmond to look at specifically the racial inequity of pedestrians in that city. In this case it was found that 32% of the population live in poverty and many were forced to walk across dangerous, major highways without sidewalks or crosswalks to get to where they needed to go (City Data). This case brought to attention the need for more pedestrian accessibility in future city space which is a major concern for pedestrian advocacies.

The other side of the coin comes from the AV promoters who are fully committed to informing the public about how worthwhile and safe autonomous vehicles will be. These promoters are working to provide reasonings and evidence as to why AV technology should be incorporated into the city space and how cities are designed. The Association for Unmanned Vehicle Systems International recently did a survey amongst Americans and found that 80% of correspondents believe that the most important priority is to educate the industry on trend and technologies and promote a positive industry image. They feel that the benefits and values from AVs are the most important thing and that will be enough to get them into society (AUVSI). Companies like AUVSI are preparing to get AVs implemented into society by informing the public of what a world with AVs would look like and why we need them. In economics, the term for this is "using their agenda to convince the public". These companies have the desire to make AVs a majority of transportation and mobility in the future city space. Another important point that they bring up is that according to the Connected Vehicle Trade Association, vehicle communication is vital and there cannot be safety without it. (CVTA). They believe that AVs need to play a major role in the future city space because of the safety they can bring. Important piece of the argument is that AVs eliminate any issues relating to drunk or drowsy drivers. The future incorporation into the city space is just one part of the ongoing AV debate.

Another issue that is causing some controversy is the financial aspect of autonomous vehicles and the role that government needs to play in the regulation and control of AVS. Although AV promotors recognize the high costs of AV technology, they feel that the benefits of the technology will far exceed the costs. According to Quartz, to make a normal vehicle into an AV requires an additional $250,000. A major aspect of AV technology is Lidar which is $85,000 on its own (Quartz). Although the cost is high, these companies strongly believe that more safety

will come with autonomous vehicles and that safety is well worth the additional cost. In addition, some companies such as Tesla and Waymo say that their AV technology is not that much more costly and is only estimated to be around $8000 (Quartz). According to the Harvard Business Review, $156 of added taxes per household get used to pay for vehicle accidents (HBR). AV promotor companies believe that their technology can bring this number down and keep people safe. The question is how safe with AVs actually be and does the safety outweigh the costs? Pedestrian advocacies believe that they have the answer to that question. PEDS of Georgia says that based on research, “Bad engineering breeds bad driving” (PEDS). Making safe crosswalks in one of their accomplishments but they fear that autonomous vehicles will ruin that work. For the longest time pedestrians were not on radar screens. This shows why they need to fight for relevance in society through better mobility access and more city infrastructure suited to their needs. In addition to pedestrians having concerns about AVs, community members have their concerns as well. After interviewing many pedestrians, Botello found that many believe that AV implementation into society will result in pedestrian behavior becoming unpredictable which will cause more accidents instead of preventing them (Botello). Another key part of the debate that came from this study is that some feel that AV compliance with the law will be hard to watch. A significant mismatch between both sides of the debate is the role that the government will play if AVs get implemented into society.

The biggest worry of pedestrian advocacies is that the federal government continues to treat AVs as the same species as normal vehicles. They believe that, “the potential life saving benefits will suffer if the federal government does not implement any regulations on autonomous vehicles” (Roth). Pedestrians are worried about their safety and if something does happen, they want to make sure the law is there that holds AVs and AV companies accountable. States have

begun to pass similar but also conflicting laws which could lead to issues. Specifically, problem with mixed laws arise when it comes to how AVs are legally defined, the requirements to possess and operate them, and who bears the responsibility to fix and maintain AVs. Right now, the only plan is for the Federal Highway Traffic Safety Administration to start creating a plan. For AV promoter companies, it is important that all forms of government play the role of informing the public of the benefits of AVs and preparing infrastructure to incorporate AVs into society (New Mexico Law Review). They see government as a way to focus city infrastructure and readying communities for AV implementation. All in all, the role of government is a major point of controversy that is being fought over between the two sides.

To better examine this issue, the case study of Denver Colorado is going to be used to examine the varying interpretations that different groups might have on the issue. Looking at the competition through a SCOTS perspective, the two sides of stakeholders have a varying perspective on what safety looks like in a society with autonomous vehicles, as well as the role of government in this envisioned future city. In an actual study done by RTD Denver, an AV was put into action in downtown Denver (Genova, 2019). The group collected data even though this was the simplest of scenarios for an AV. The group concluded, after the vehicle ran on weekdays for a set amount of time, that it was a success because it was able to accommodate people with disabilities and there were only minor disruptions. This represents the mindset of AV promotors and their definition of success. AV technology specialists and promotors have a different definition of success and in turn a best future city because they have bias toward the technology that they are creating. In their minds, the technology is successful in that they had no major issues but for pedestrians' groups there is concern over the issues that did come up. As in many cities, Denver also has no laws designed specifically for AVs which align with how AV

promotors feel about the role of government with AVs. On the contrary, city dwellers and pedestrian advocacies, such as Walk Denver, have different viewpoints. Walk Denver feels that the AVs are not going to be successful or safe until they are proven to have no incidents with pedestrians. Groups such as these define safety as having no incidents with pedestrians because they are the ones getting hit most often and at such a high rate. They believe that in order to be safe, AVs need to be able to handle any situation they are put in before being implemented into any future American city. A chief concern in Denver is also how will the government play a role in placing regulations on AVs. Denver Moves, another pedestrian group, came out said that there needs to be additional regulations on AVs because of the all the new accidents that could be caused by them. They believe that because of the uncertainty and new types of accidents that could occur, the government needs to hold them responsible for pedestrian accidents and deaths. All in all, both sides of this competition, for their influence in the future city, have different representations of what the best city would look like in addition to different viewpoints toward issues regarding AVs.

Discussion

The debate over the safety, cost and importance of AVs is something that will be debated for years to come or until the technology is ready to be put into use. This issue exists all over the world, especially in countries such as China, Norway and The Netherlands where AV technology is in its initial stages. The technology is progressing so much that there is an AV technology readiness index. The United States ranks 3rd in the index of being "ready" for AVs to be implemented into society. Although there is this readiness for AVs from the standpoint of countries, there is no index that can capture the readiness of the people for the incoming technology. Everyone is going to have their own feelings about AVs and the role they should

play in the future. It is this idea and struggle that is the foundation for the competition between pedestrian advocacies and AV promoter groups. With so much uncertainty that comes with AV technology, this competition for a role in society will continue to go on. AVs will change so many things about society, especially for the many pedestrians all across the country. It will also change society for the many people who are excited about the possibilities of AVs and will certainly buy driverless cars when they get put into society. This study brings about future areas of research such as should people be allowed to own self driving cars if AV technology takes over society in the future or how will societal influence play a role in convincing more and more people to switch to AV technology. Specifically, AV promotors want to see a city with AVs running society and everything becoming automated. A city full of automated buses, cars, taxis, Ubers, etc. In addition, their city will be better adapted for these vehicles with wider lanes for bigger AVs and newly designed intersections since obstacle detection will allow for new intersections. Pedestrians see a city full of people walking around, more and wider sidewalks and more laws to protect them in the case of accidents. One thing that I would like to investigate in the future is will the AV revolution be as more or less rapid as the hybrid car revolution. With so much backlash from groups such as pedestrian advocacies, it will be interest to take a look at how the two revolutions compare and what the implications of the hybrid cars have on the future of role of AVs. All of these questions highlight the potential and importance of this competition.

Conclusion

With so much information and complexity that comes with AV technology, it is important to understand the views and thoughts of all sides of problem. As time goes on and the technology becomes more and more advanced, the competition and fight for a significant role in society will strengthen and soon social media will be spreading the agenda of AV promoters

even more because of all the excitement that AVs could bring. That is one reason why pedestrian advocacies are working so hard to fight against AVs and bring more attention to the dangers that pedestrians already face every day. This debate can be looked at through the viewpoint of the tragedy of the commons. The role in society is something that everyone has open access to but AV promoters and pedestrian advocacies are working to spread their own agendas and their interests in order to change the way society operates. With this fight for the future of city space, design, mobility and transportation, a significant component of analyzing the two sides is the axiological component. The values of these group are what fuels them in the same way that gasoline fuels a car. These groups care about society and want what is best for it and the members of their group. The implications of AVs on future cities are monumental because laws, designs and the lives of individuals will all be affected and it is these massive implications that are the reason these groups are working so hard to enhance their own role in society. It is because of all the possible implications mentioned throughout this paper and all of the lives affected by this future technology that show the importance and longevity of this fight for future city space, design and mobility.

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