

Autonomous Vehicles and Their Impact On Society

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**Abstract:**

Autonomous vehicles(AVs) are an idea that has been floating around for years in our society. Technology is always evolving and transforming our lives, and this is possibly the next big thing that will change the way we travel and interact with the world. Although this type of technology is still new and has a long way of being used by the average person, it has the potential of changing the way we get to places. Autonomous vehicles are basically cars that would be able to drive us to destinations with us barely interacting with it. This emerging technology of autonomous vehicles will have far-reaching applications and would have a great impact on things like jobs, transportation and the environment we live in. This paper will look to analyze the impact that AVs will have on society.

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## Introduction

The evolution of the car has begun ever since humans invented the wheel. Over the period of time, humans shifted the concept of transportation from the animal dependent vehicle to the motor engine vehicle. Back in the days the vehicle was dependent on animal muscle power such as horses, donkeys, and cows, yet still in some underdeveloped countries use the animal vehicle for their daily commuter. But ever since science has invented the motor and the six-cylinder engine for the car, it has become the number one commuter media in the twenty-first century. People can not think about their lives without cars to this day now. In this era, every car company is in competition to provide the best service to their customers and are trying to provide additional new features to their car to attract new and old customers. Today, companies worldwide are now working to enter the driverless vehicle market.

As society is evolving along-side technology, our dependency on technology is growing. This has led to the development of Artificial Intelligence and more importantly Autonomous Vehicles. Autonomous Vehicles are vehicles that combine sensors, cameras, and software to regulate, navigate, and drive the vehicle without human assistance. Automation is broken down into several levels. It starts from level 0, absolutely no automation, to level 5, where the vehicle has no help from the person in any driving condition. With this rise of automation, the biggest thing on people's minds are the impact they will have in our society. How efficient will they be and will people lose their jobs because of them? There may be some downsides to the rise of autonomous vehicles, but our group will demonstrate that the advantages far outweigh them.

### **The History Leading Up To Now**

The history of the autonomous car or the self-driving car started in the middle ages, centuries before the actual car was invented when Leonardo Da Vinci first developed a self-propelling cart. He wrote detailed plans for a robotic cart capable of powering itself in the 1500s. It has been considered the blueprint of the self-driven car. The reality of this car concept started in 1925 when Houdina Radio company first launch a driverless car named radio controlled 1926 Chandler. This driverless car ran between the fifth avenue and Broadway and guided through traffic based on radio signal sent from another car following close behind. The reality of self-driving car came to a vision on the 1939 World's Fair when a renowned industrialist named Norman Bel Geddes introduced "Futurama" (Hodgson, B., 2017). In that fair "Futurama" become very popular not only for its innovative idea but also for the realistic possibilities for modern city life. In this project, he introduces an exceptional highway which will link the cities and surrounding communities. An automated highway system for the automated car where a car will function everything by itself and passengers will board and get off in their destination safely.

Later, in 1977, a team from Japan's Tsukuba Engineering University took the first steps to build a prototype of a self-driving car. Their prototype is been considered the first stand-alone autonomous vehicle. In this technology, instead of external road support, they have built up car own machine vision which helped to guide the car analyzing the computerized data collecting the image view from the built-in camera. Unfortunately, this car wasn't able to speed up to more than 20 miles per hour (Hodgson, B., 2017). By 2013 all major automobile companies such as

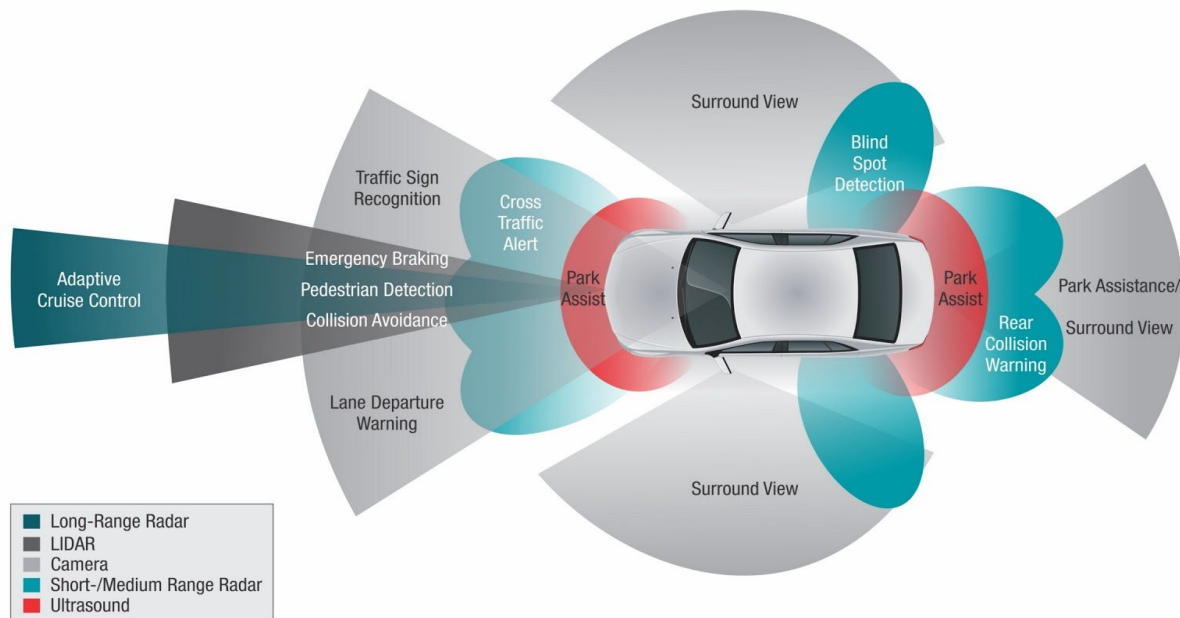
General Motors, Ford, Nissan, Tesla, Audi, Mercedes-Benz, and BMW Belgium were investing in their self-driving car project.

In 2009 Google launched their self-driving car named Waymo. In 2017 they build a fully driven minivan for mass production which is fully autonomous. According to the article, *Rage against the machine? Google's self-driving cars versus human drivers*, the authors reveal that Google self-driving cars, while a test program, are safer than conventional human-driven passenger vehicles (Teoh and Kidd, 2017). Waymo drove fully autonomously over ten uninterrupted 100 - mile route in their own Toyota Prius vehicle and a month later this project has driven the order of magnitude larger than had any project drove autonomously. Google cars were involved in a few crashes but only 3 were judged to be police-reportable (Teoh and Kidd, 2017). The rate of police-reportable crashes for Google cars was lower than the rate of police-reported crashes of human-driven passenger vehicles.

### **The Mechanism of the Autonomous Vehicle**

Just as we humans must be able to see to drive, so do self-driving cars, and they see through sensor technology. They use various sensors, radars, and cameras to navigate and drive. The main mechanism of the self-driving car is based on artificial intelligence. AI runs through the laser range-finder mount which is situated on the roof of the car and it works like the heart of the car. A Velodyne 64-bar laser produces a point by point 3d map of the environment. The car combines the laser measurement data with the world's high-resolution map. During the combination, if the results are different from the model world map, then it takes necessary steps to avoid obstacles and follow the traffic law. Besides the laser beam, AI also carries sensors and front and rear bumpers. Moreover, AI has four readers, which allows the car to see far enough to

able to deal with fast traffic on the free highway.



*Figure 1: Sensors Distribution of a Automated car*

The diagram above illustrates how an autonomous vehicle perceives its environment through a combination of sensors. It is a radar like technique that uses invisible pulses of light to create a high-resolution 3D map of the surrounding area. The three sensors: cameras, radar, and lidar complement each other. For instance, cameras can see street signs and road marking, but can not measure distance. The radar can measure distance and velocity, but can not see in fine detail. Finally, lidar provides fine detail since it generates 360 degree maps of the vehicle's surroundings.

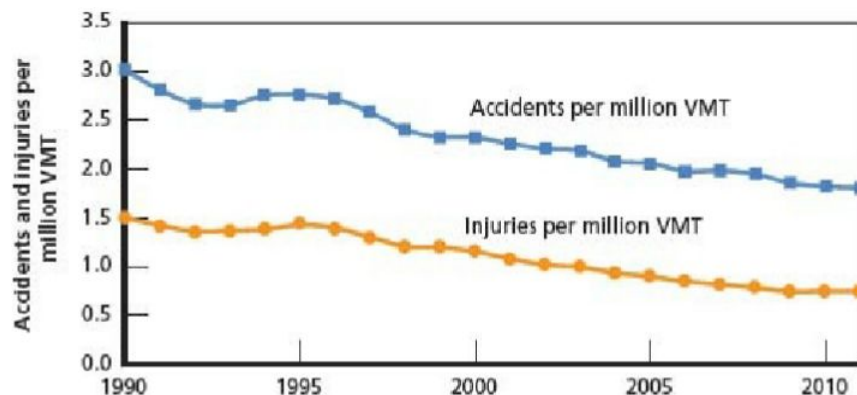
Other key components of the autonomous vehicles are GPS, ultrasonic sensors, and central computer. GPS triangulates position of the car using satellites. Also, GPS finds the vehicle's location and keeps track of its location. Ultrasonic sensors use high-frequency sound waves to measure velocity and proximity to nearby objects. The central computer is also known

as the “Brain” of the vehicle because the computer analyses information and controls steering, acceleration, and braking. Research on intelligent vehicles and intelligent driving innovation is directed to improve transportation security, anticipate and diminish auto collisions, decrease fuel utilization, limit natural contamination, and quicken social knowledge (Li, D., & Gao, H. , 2018). With all this background on these vehicles, we can move on to talk about their advantages.

## The Positive Effects

### Safer Streets

These new vehicles will affect us in a major way for the better. One of the main benefits of autonomous vehicles is that they would make the streets we drive on safer. This has been proven by the experiments done to show how much they could benefit our society. An example of this can be seen from the 2007 benchmarks for autonomous driving in realistic urban environments. It showed that with these vehicles, 90% of traffic accidents could potentially be gone and the pollution in our environment reduced (Janet, par. 1). The reason this happens is because it removes the possibility of a person driving while drunk, being on their phone or just not looking on the road because of doing something else. This is why human error plays a major part to the accidents happening on the roads. Although accidents and injuries are going down because of the technology getting better over the years (Figure 2), it is still shown that accidents are still over the millions every year.



*Figure 2: Graph of accidents and injuries per million vehicle miles traveled (VMT) in 1990 - 2011 (Source: <http://ebookcentral.proquest.com/lib/ccny-ebooks/detail.action?docID=1603024>).*

In terms of safety, autonomous vehicles are always going to be active and pay attention to what is happening to their surroundings. In 2013, there was a research done by the World Health Organizations, which states traffic accidents are the main cause of death for 15 to 29 year olds (Millard-Ball and Adam, p. 30). The research is an example that human error is a real thing that happens. These accidents causes people to waste money on repairs, which is shown by the NHTSA in 2002 cost to be \$230.6 billion a year. This is not to say that the first generation of real autonomous would be perfect, but it will be active at all time, unlike humans. It would be the first step to better safety.

Another safety measure is that these vehicles would have multiple cameras and sensors that would over time learn from the experiences all the autonomous vehicles would have on the road because of all the data engineers would have stored from them (Janet, can government regulation keep pace?). This is important because unlike humans these machines would be able to gain all the data from accidents and other events and with time these vehicles would make better choices than we ever could. Meaning that in the future we could see less accidents and mistakes on the road, which would lead to less deaths. These are a few aspects of safety that AVs will bring to society.

### **Environmental Effects**

Another benefit that AVs will bring into society is the positive environmental effect. These cars have already became such a big deal, that “in September 2016, the US Department of Transportation issued the very first Federal Automated Vehicles Policy” (Janet, can government



regulation keep pace?). This might sound like it would hurt the future of autonomous vehicles, but it actually doesn't. This policy would make it so the cars would be tested carefully so that it is safe to be on the streets. The policy would benefit everyone. The public would trust the automated cars and use them because of the government forcing companies to do 15 safety standards and have safeguards, which will be used for when there are system failures. These are ways in which AVs will provide environmental benefits.

Moreover, autonomous vehicles will help reduce the amount of damage non-autonomous vehicles produce in our society. This is shown by the driverless pods used in the U.K. to help transfer tourists around the park's roads (Scott par. 8). These cars would be electric powered, which means they won't produce pollution in the air. The operator of this park main objective was to have less traffic and pollution on the roads. This proves that they are trying to make the environment better by having less cars on their roads that use gas, instead of electricity. This experiment shows a small scale to what could be the future, which is us using autonomous vehicles to reduce harmful things non-autonomous cars do. What will also help is that these cars could be programmed to be eco-driving. This means that that the automated vehicles can use the available technology and software it has to reduce the amount of fuel used while driving. It has even been shown that it can "improve fuel economy by 4 to 10 percent"(Millard-Ball and Adam, p. 46). It might not look much, but it does show that if programmed right, it can reduce the amount of pollution and oil used everyday when autonomous vehicles became more mainstream.

Therefore, these are a few ways in which AVs will benefit our environment.

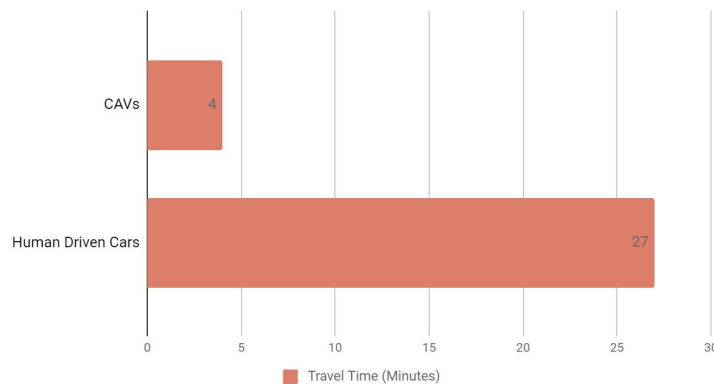
### **Effects On Transportation**

Not only are these vehicles going to be safer and more environmentally friendly, but also provide us better transportation and efficiency. An example of this can be seen in the “accessibility for non-drivers, who may for instance be elderly, disabled or children” (Scott, par.8). The reason this is true is because of not needing to drive autonomous cars. The vehicles would just need to know the location of where the person wants to go and get there faster, without waiting for a taxi or someone who can actually drive. This makes it easier for them, since there is no need to worry about being in an accident or making wrong turns. The passenger won't need to worry on what is on the road, leaving them to be relaxed until they get to their destination. This changes the way the elderly and the disabled interact with the world. They would be able to go outside more without needing assistance or using the train and bus, which could have been hard for them.

With this being said, there are potential benefits to everyone looking for faster transportation and this is “24/7 on-demand CAVs”(Scott, par. 39), with CAV standing for Connected and Autonomous Vehicles. This could change the way the everyday person goes to place to place, by having them ride a car and that same car going to someone else when it is not in use. Instead of them using trains, buses, taxis or apps like Uber, they could use CAVs, which are faster and safer. This is because of them being less likely to cause accidents and wrong turns, which could slow them down to where they needed to go. The impact these will have on traffic, parkings, and pollution, especially in big cities like New York City will be huge. It would reduce all of these because of not needing a bunch of cars, when the same car could be used to help multiple people a day move them place to place. An example of 24/7 on-demand CAVs already being tested is in the UK. They have done an experiment showing how something they call,

“pods on demand” will help travellers roam around their airport. The experiment showed they can save time and carbon with just CAVs alone in the airport (Figure 3). This potentially could have people prone to use CAVs because of how convenient they could be and not needing to buy

CAVs Vs Human Driven Cars



or rent a car.

*Figure 3: Heathrow Airport CAV experiment done in the UK. They claimed it reduced travel time and carbon with CAVs in their airport.*

## The Negative Effects

### The employment impact on society

While looking at the benefits automated vehicles will bring to us can show us how promising they can be, it is important to also take a look at the negative effects they will pose. The biggest concern with automated vehicles is the impact they will have on jobs. As huge innovations in automated vehicles are being made, people are anticipating the introduction of them and with them the displacement of jobs. This is with good reason because as AVs become more practical, businesses could see much capital investment in them to substitute many areas of the workplace. The areas that will be greatly impacted will be those of the motor vehicle operators as well as on-the-job drivers.

To no surprise, the biggest sector of society that would be greatly affected by these AVs is the transportation and warehouse industries. Many of the people that work here are motor

vehicle operators such as truck drivers. “In 2015, there were 3.8 million workers in these occupations. These workers were predominately male, older, less educated, and compensated less than the typical worker “(David Beede, Regina Powers, Cassandra Ingram, 2017, p.1). This shows us that the majority of jobs that will be displaced would be to a sector of society that would need help if they lost their jobs. Since most of these people don’t have much education and are older, it means they don’t have many transferrable skills and they will have a tough time when they are displaced. Although this is a major problem that AVs will bring, there are some solutions to help mitigate this impact.

This impact on jobs can be remedied through government programs or even company programs that would encourage employees to go to school or get training for future jobs. It is still early enough for this to be implemented and for workers to go through such programs. Such programs can be helping these drivers get education in computer skills to help them transfer to a job in this computer savvy world. It is also important to note that while there may be a lot of jobs for these vehicle operators that will be affected, they only make up 3% of the total workforce, as we can see in figure 4. That means that there will still be plenty of jobs that AVs won’t be able to affect. While these motor vehicle operators will be negatively impacted, the same can’t be said for the on-the-job drivers.

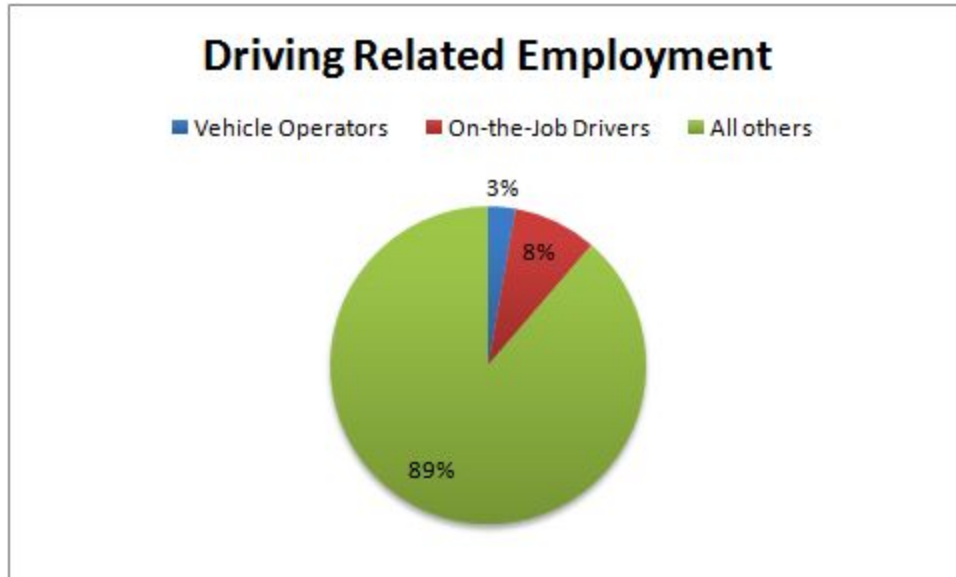


Figure 4: Driving Related Employment percentages (Source: *The Employment Impact of Autonomous Vehicles*, David Beede, Regina Powers, Cassandra Ingram, 2017)

For the other sector that would be impacted by these AVs, on-the-job drivers will actually seem to benefit from this technology. First, many of these jobs are jobs like first-responders, technicians and even waste management. It is important to note that these jobs require drivers but are not only for drivers. These jobs require other skills or at least general physical activities which AVs will not be able to have as big of an impact on. That means that many of these jobs will still be available even with the introduction of AVs. These activities, being relatively important, suggest that for many of these occupations there will be a role for humans to work in conjunction with these vehicles. This will also allow the people in these jobs to focus more on the specialization of the job, such as technicians being able to focus more on their specialization.

While the introduction of automated vehicles will have a big impact on society and many jobs of people, we can see that it all won't be so bad. In some jobs it will actually help people, and in other jobs it will cause displacement of jobs. For the jobs that are displaced, we can start programs that will help these people transition into new jobs when the time comes. It is still early

enough since the technology is still young for us as a society to look into creating programs that will help this sector of society.

### **Weak security measures**

Another negative effect that will be posed as AVs advance will be the potential threat cyber security attacks could have. As we move closer to full autonomy, we will become more dependent on computer and digital systems that will in turn mean we will become more dependent on their security measures. These systems should be created with having the idea that will be put up against cyber-attacks, software and hardware defects and must be able to react to such events accordingly. This can pose a huge threat because these attacks can be used to cause serious accidents that can result in the death of passengers and pedestrians or even worse, potential for cyber-terrorist attacks. As it stands right now many vehicles have weak cyber security measures that will pose a bigger threat as they move closer to full autonomy.

The reason we currently have these huge flaws is due to the controller area network(CAN) in cars currently. Its flaws come from the fact that this was developed in 1988. Although it has been updated in 1991 and 2003, it's still very outdated and heavily flawed. The CAN was developed before wireless technologies were popular and before they thought about networking cars together. Therefore, it was weak protocols against external attacks and even internal ones. This is made worse due to the fact that many components of the car are controlled by the electronic control unit(ECU) and networked together though the CAN protocol which, again, has weak security measures. Some of the notable flaws it has are its broadcast nature, fragility to Dos, and a lack of authenticator fields. These cyber-vulnerabilities will pose a big

deal for autonomous vehicles are we progress. It will be important for companies to implement new and better security measures.

Some improvements that can be made to the vehicles can be things such as including cyber-security requirements. By requiring manufacturers to think about cyber-security, it will push them to start implementing them from the beginning of the development rather than at the end when the system has already be set up poorly. Another thing that can be done is implementing the use of electronic counter measures and jamming resistant modules. All these again can be required from the beginning to push developers and manufacturers to include these from the start in the idea process. This will prevent unnecessary and poorly planned measures to be added at the end. It is important to also acknowledge that there is no absolute cyber security that will not be susceptible to attacks, but we must do our best to mitigate these dangers.

### **Conclusion**

While we are still far away from a complete autonomous car roaming around the streets, taking us place to place, we already have seen experiments done to show it can be accomplished. It is important for us to understand what benefits and harms AVs will bring because as we grow up in this technology inclusive society, we can be better prepared for these effects. The benefits such as the streets we drive on being safer, and the improvement in transportation getting us to places faster and more efficient are prime examples of effects these new types of vehicles can have on our society. Yes, they will change the way we work and get things done in our lives, both being good and bad. But, this has always been a thing that happened in the past, showing us that things like jobs in many fields, not being needed after the technology has advanced. We are

always evolving and this is the new thing that will change us for the better, but we need to get over the bad effects to get to the great effects.

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