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Social and Environmental Impacts of Driverless Cars

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ANNOTATION

The automotive industry is accustomed to adapting to manufacturing automation. New challenges for automotive production are emerging, due to automation. In this article, we talk about how fast such kinds of vehicles are advancing and adopting. We highlighted several themes related to autonomous vehicle use that we examined the advantages and disadvantages of driverless cars for individual road users. Referring to the opportunity of choosing the most appropriate vehicle for each trip was a relevant topic to discuss. We conveyed a small survey to reach spatiotemporal aspects of this topic. We provided an estimate of how long it will take to overcome several problems as well as examined driverless car predictions. As vehicles have potential benefits and costs. We examined how they affect travel activities and impact road, parking, and public transport planning. We concluded the topic with our thoughts that the advantages of self-driving cars far outweigh the disadvantages. This research opens several future research topics related to social, economic, and geographical matters of autonomous vehicles and technologies.

KEYWORDS: driverless cars, automation, advanced technologies, geography, social, environmental, predictions, spatiotemporal, transportation, travel

1. Introduction

The automotive industry is accustomed to adapting to manufacturing automation. The introduction of robotic vehicle manufacturing in the 1970s has resulted in significant cost savings and increased reliability and flexibility in mass vehicle production. Today, new challenges for automotive production are emerging, due to automation. However, this time it is not the manufacturing process, but the vehicle itself. There are certain impacts of autonomous vehicles – also called self-driving, driverless or robotic vehicles, and their implications for transportation planning.

1) Highlighted themes

a) Mentioning several advantages of driverless vehicles for individual road users.

b) Reference to the amount of time when a car is not in use.

c) Reference to the opportunity of choosing the most appropriate vehicle for each trip.

d) An estimate of how long it will take to overcome several problems.

e) A suggestion is that the use of driverless cars may not affect the number of vehicles manufactured.

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2) Research questions

1) What are the benefits of automated vehicles?

2) What challenges automated vehicle development can face?

2. Literature review

Mohsen et al. (2016) analyzed the problems and opportunities associated with transport policy that may arise because of the emergence of autonomous vehicle technologies. Autonomous Vehicles has presented research on how to reduce transportation costs and increase access to low-income households and people with mobility problems. *Jason Monios and Rikcard Bergqvist (2019)* offered an intermodal transport analysis to map the evolving geography of driverless vehicles. They analyzed the features, challenges, business models, and policy implications of how this can help in better vehicle development planning in their work. *Cugurullo, F., Acheampong, R. A., Dusparic, I., and Gueriau, M. (2020)* illuminate the city's transition to autonomous transportation in three ways. They developed a theoretical framework for understanding the prevalence of autonomous vehicles in cities based on social relations, technological innovation, and urban policy. *Hassan, Hany M. & Ferguson, et al., (2021)* analyzed the experience of older adults behind the wheel by making driving safer, easier, and more enjoyable than advanced vehicle technologies. They reached their work to the prospects of autonomous vehicles for adults. In this article, we link the topic of travel and self-driving cars to the topic of spatial and temporal analysis and social impact. In doing so, we relied on the scientific work of Dr. Song Yena. *Song (2018)* provided an analysis of transit capital and the changes in it because of the large expansion. 'Gini index' explored the issue of transit capital and social equity at the global level using the concept of the index. *Todd Litman (2022)* offered an analytical study on the advantages and disadvantages of self-driving cars. He also focused more on the transport economy. Based on the above scientific sources and relevant data, we examined the social and environmental impact of driverless cars in our article by linking it to the field of transport geography.

3. Background of the research topic

If the vehicle can take over part or all the journey, it may be possible to be productive, sociable, or simply relaxed while the automation system is responsible for controlling the vehicle safely. Vehicles with limited autonomous driving functions have existed for over 50 years and are making a significant contribution to advanced driver assistance systems. If the vehicle can be driven, those who challenge existing mobility models, such as the elderly and travelers with disabilities, will enjoy much better travel autonomy. According to a study, human error is the cause of more than 90 percent of road accidents, most of which are the main causes. However, progress in this area has accelerated since *Google* announced *(2010)* that it would test self-driving cars on roads *(US, California)*. The Vehicle Automation Research Project is not new (*British Institute of Transportation*).

4. Driverless cars' impacts

It is necessary to give short answers to the questions because these short answers will be the prelude to the topic discussed in the next lines.

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First, voyagers may travel by doing something other than driving when they use driverless cars. Also, it is very convenient for those who find it physically difficult to drive a car can travel independently.

Second, we should make sure that the public is confident in autonomous vehicle use. It is important to adapt the autonomous vehicle to different driving conditions.

According to the data, driverless cars were "expected to be commercially available and legal in some jurisdictions by the end of 2020", but primarily this was not fully grasped due to the high cost and limited performance nature. It is now estimated that some privileges for wealthy persons who do not want to drive or cannot drive to use autonomous vehicles can be ongoing in the 2030s. But if such privileges increase, then autonomous vehicles might commence proliferating, and prices will also decrease (*expected in 2040-2060*). As a result, low-income people and/or pedestrians are expected to move independently and therefore the need for public transport is expected to decline. In addition to these direct benefits, you can consider the wide range of transportation and social implications, and how the manufacturing process needs to be addressed. Today, the average car spends more than 90% of its life on parking (*Google*). Automation means that car-sharing initiatives will be much more viable, especially in urban areas where travel is highly needed. If a significant portion of the population decides to use shared self-driving cars, mobility needs can be met with far fewer vehicles. Besides that, pollution diminution is significant. However, the issue of improving security, and energy-saving remains relevant. Also, some benefits may require autonomous motor corridors, which raises problems of social equality. That means driverless cars are likely to have different *social equity impacts*. The positive forecast is that autonomous vehicles (*especially, electric ones*) will reduce possible problems or disadvantages because self-driving cars are designed to reduce pollutant emissions compared to fossil fuel vehicles, but the real impact is uncertain and depends more on general vehicle traffic and government policy incentives. And then to maximize fair-mindedness, public roads should arrange *space-efficient modes* of transportation and manage limited traffic to road capacity.

Table 1. Driverless cars' expected benefits and problems

Advantages	**Disadvantages**
Internal effects:	
Diminish human stress while driving and growing efficiency. The driver can take a rest, play games, and/or work while driving. Decrease the cost of taxi services and commercial transport drivers.	Additional accidents are caused by system failures, platooning, faster traffic speeds, additional risk-taking, and increased vehicle-wide movement. It can be susceptible to information misuse (due to hacking), and features such as location tracking, and data sharing can jeopardize privacy.
External effects:	

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More useful vehicle traffic can decrease overcrowding and roadway costs. Decreases extra parking needs at destinations. Promote car-sharing and ridesharing, reducing overall ownership and associated costs of vehicles and travel.	Higher roadside design and care standards may be needed. Augmented vehicle traffic can rise crowding, pollution, and costs related to urban mass. Reduce cheap transportation such as walking, biking, and public transport using. In addition, jobs in the driving profession are drastically cut-rate.

Source: Victoria Transport Policy Institute, May 2022.

Table 1 shows that self-driving cars have a variety of benefits and costs (or difficulties), including many *"external"* costs, especially those made by others. So, these external disadvantages might bring congestion (*overcrowding*), pedestrian delays, road and parking costs, risk of accidents, and emissions of pollutants that driving a car are unfair.

5. Discussion

So, we should mention that as self-driving cars become more common, this becomes more and more important, increasing potential travel demand. According to the Victoria Transport Policy Institute, *shared* driverless cars include self-driving taxis. These self-driving cars can improve the number of vehicles by designating a special lane, but in many cases the impact on congestion is mixed. One of the settlements is that it reduces possible traffic accidents that *occur because of human error*. The self-driving vehicle services are supposed to be cheaper than *man-operated* vehicle services, but the quality of service is inferior because there will be no chauffeurs to ensure the safety of luggage or passengers, which means that system failures increase the danger. For instance, if such a system does not work, or you do not have a detailed map required for a driverless vehicle, you will not be able to reach your destination on time due to bad weather such as heavy rain or snow, and you may feel *"insecure about access"*. (*Grush2016*). The regulatory challenge of understanding how responsibilities and enforcement change when the driver is no longer needed to operate the vehicle. Besides that, operating vehicles on public roads is complicated by the high frequency of interactions with objects that are often unpredictable, such as potholes, vehicles, pedestrians, bicycles, and animals (*CEO 2016*). Social changes may be needed for communities to trust and embrace self-driving cars as a valuable part of their mobility landscape.

Figure 1. Aircraft and Automobile Software Code Compared (GAO 2016)

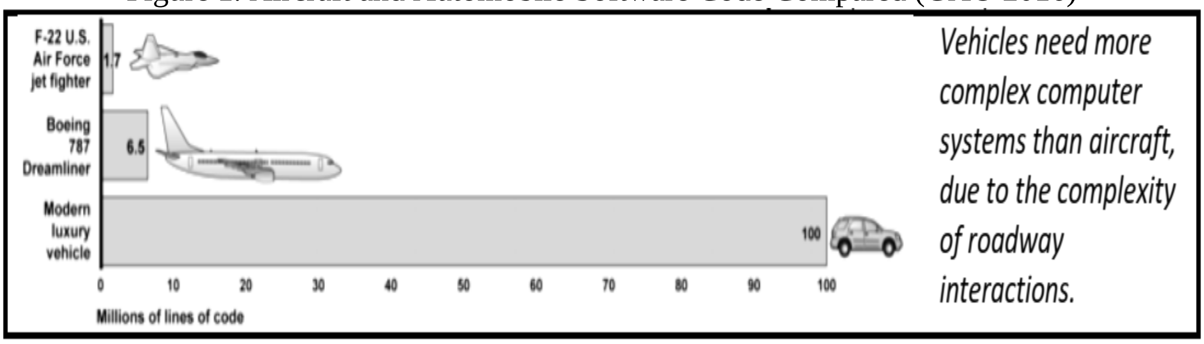

Photo credit: Victoria Transport Policy Institute, May 9, 2022.

Self-driving cars require orders of magnitude more complex software than airplanes (fig. 1). There is no doubt that creating such software is difficult, expensive, and buggy. System

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failures will almost certainly occur, some of which can cause serious accidents. Therefore, testing and re-approval can take years (*Bhuiyan2017*) if the technology turns out to be unreliable and dangerous, such as when self-driving cars continue to cause serious accidents.

When it comes to "amusement rides" such as micro-transit services have the potential to become widespread in the 2030s. Thus, shared micro-transit expects to require travelers/users to share space with *strangers*, and additional pickups or drop-offs can cause delays and lessen speed and trustworthiness. *On the other hand*, optimistic (*i.e., positive*) forecasts about the advantages of driverless cars may decrease support for public transport services in some communities and limit *non-driver mobility options* (*Creger, Espino, and Sanchez 2019*). So, by providing more affordable taxi and public transport services, reducing total vehicle travel, improving pedestrian and cyclist conditions, and reducing the need for parking, shared self-driving cars can share city life and vehicles (*Lovejoy, Handy, and Boarnet 2013*). As a result, the overall impact of travel depends on the proportion of households choosing cities over suburban and rural areas and the share of self-driving cars.

If we move to a model where consumers tend not to own a single vehicle but to purchase access to a range of vehicles through a mobility provider, drivers will have the freedom to select one that best suits their needs for a particular journey, rather than making a compromise across all their requirements. Since most seats in most cars are vacant most of the time, this can spur the production of smaller, more efficient ranges of cars to meet individual needs. After that, a special vehicle may be available for an unusual journey, for instance, to support a boy or daughter on a camping trip with his/her family or on his/her way to school.

According to a study by the Victoria Transport Policy Institute (*Autonomous Vehicle Implementation Predictions, 2022*), some "optimists predict that shared autonomous taxis will soon displace most private vehicles" (*another source is ITF 2014; Keeney 2017*). Because "self-driving cars can play an important role in reducing the number of *"fatalities" from traffic accidents* and providing a safe, productive, and efficient driving experience (*NHTSA*). According to some studies, the introduction of fully automated vehicle replacement requires less than 30% of the vehicles currently in use (*Massachusetts Institute of Technology, 'Singapore Study'*). This can mean that very few cars need to be produced to meet that demand. However, the number of trips (*or travels*) increases because 'empty vehicles' need to be transported from one user (i.e., customer) to another.

1) Using automated vehicles as individual

I conveyed a little survey about self-driving cars' use in time and distance. The survey asked questions about distance and travel, in terms of what it might be like to use an automated vehicle. For example, "*How would you consider using automated vehicles?"* As an option, the answers were "*as my private car*", "*as a shared car individual use*", "*as a rental car*" and "*I will not use them*". So, 65% of the total participants (about 100 participants) answered that they use driverless cars as their vehicles. Fewer users reported the lowest share (8%), they suggested using the automated vehicle as a rental. About 10-20% of respondents said they would use car-sharing individually. 89% of the participants were men.

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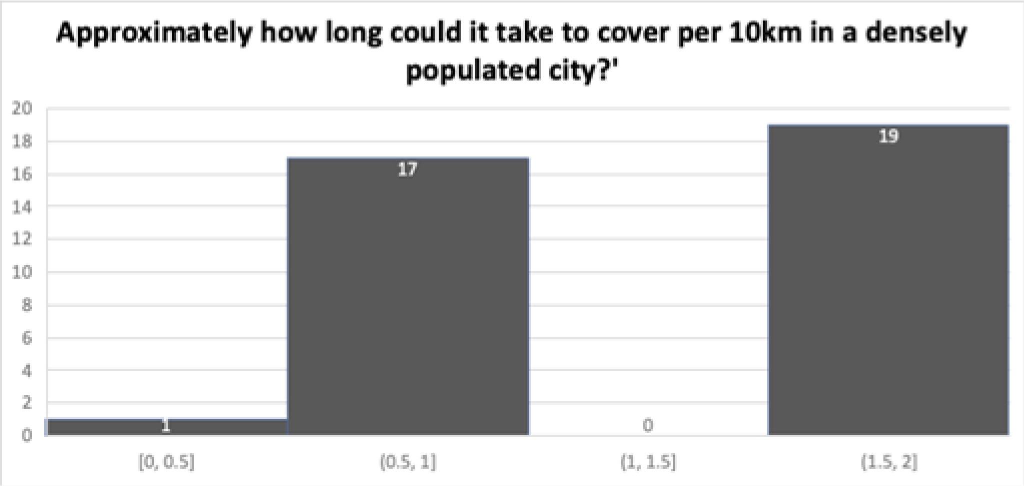
Figure 3. Analysis of time traveled 10km



Made by the author by the data of the survey

Figure 3 shows that at 10 km on a busy road, 59% were over the age of 28, 32% were under the age of 28, and 8% were under the age of 21. Fifty-seven percent of participants reported traveling at least once a week for work or entertainment, while 22% of travelers traveled at least a couple of times a week. Fifty-one percent of participants said they would travel up to 50km, and 11~14% said they would travel 70~250km. Forty-six percent said that self-driving cars can travel 10km on the city's busiest streets in more than 15 minutes. 51% say it can take up to 30 minutes on the same route. If the minimum selected distance takes an average of 20 minutes to cover 10 km on a congested road, then a calculated distance of, for example, 50 km, 100 minutes, or about 2 hours is possible. Of course, road size and travel time play an important role. I asked a question that mainly considered working hours from 9 am to 5 pm on weekdays. This suggests that there is a traffic imbalance in a crowded city. As mentioned earlier, the lack of dedicated lanes for self-driving cars suggests the need for analytical research on pedestrian and vehicle lane compatibility.

6. Future predictions on driverless cars

Governments around the world are demanding a combination of features such as *lane departure warnings* and *automatic emergency braking* to pave the way for new technologies and self-driving cars. According to analytic data from *ResearchAndMarkets.com (January 2022)*, the global size of the self-driving car market is expected to grow from 20.3 million units in 2021 to 62.4 million units by 2030, with a Compound Annual Growth Rate (*CAGR*) of 13.3% (see fig. 2). Therefore, various safety features have been developed to support the driver and reduce accidents *("Business wire", February 2022*). So, demand for luxury cars will further boost demand for self-driving cars over the forecast period (*ResearchAndMarkets.com*). According to a 'model study' on autonomous vehicles, driverless cars can reduce car ownership by 43%. As a result, the average annual mileage of cars has doubled (*University of Michigan Traffic Research Institute*). It means that each vehicle can be used more intensively. However, it should be transported as soon as possible. This shows that this rapid turnover does not necessarily reduce vehicle manufacturing.

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Self-driving cars may mean other changes in manual vehicle manufacturing. When consumers move to a model where they usually do not own one vehicle but purchase access to different vehicles through a mobility provider, the driver is best suited to a particular travel need rather than driving. You can freely select the vehicle you have. Maybe that would be a compromise overall requirement.

Figure 2. Global self-driving cars market

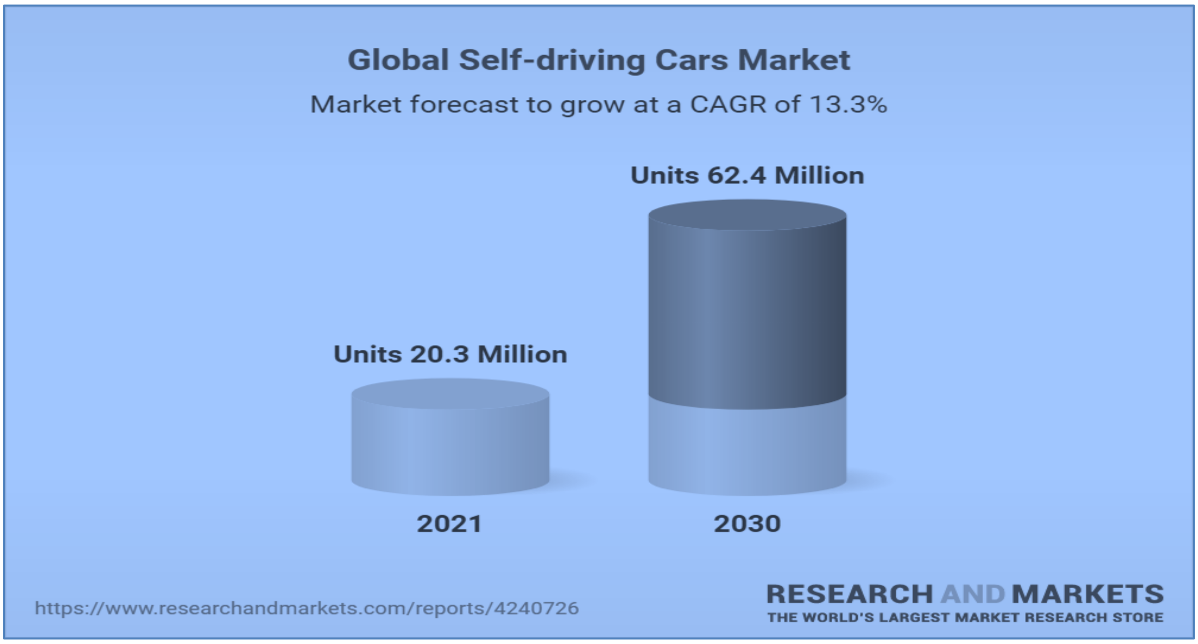

Photo credit: Research and Market (2022)

These results are at a slower pace than the optimistic predictions of some industry experts but are in good agreement with other researchers' estimates. Because by 2045, half of the new car sales could be ‘autonomous’ (*Grush 2016; Lavasani and Jin 2016; Simonite 2016*), but without obligations, market saturation could take decades, with some drivers due to cost and preference (*Kok, et al. 2017 and McKinsey 2016*). You may continue to choose *a rickshaw*[1].

Obviously, many challenges need to be addressed, but these are most likely to be overcome within the next few decades through powerful and directional research. Mobility is changing in such potentially important ways and is linked to many other technological developments such as telepresence and virtual reality, making it difficult to make concrete predictions. But there is one thing for sure. Change is at us, and the need to respond flexibly is crucial to those involved in the manufacture of vehicles for future mobility. Beyond that, the systems on which these vehicles operate to ensure that routes are optimized to avoid traffic. This not only saves people time but also reduces the emissions caused by the idling engine. Another concern is that most people are about the loss of freedom that self-driving car systems bring. In most Western countries, roads are considered a symbol of freedom and people like to travel in cars. Thus, some factors can affect driverless cars. These include features such as whether government policy encourages the development and purchase of cars, fees for roads

[1] A vehicle like a three-wheeled bicycle, having a seat for passengers behind the driver (Oxford Languages)

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and parking lots, and whether road management supports public transportation. In addition, the construction of dedicated lanes for self-driving highways is relevant.

7. Summary of the topic

Discussion and conducted research indicated that most men-operated vehicle accidents are partly due to human error, so the introduction of driverless vehicles will result in greater safety. In addition to the direct benefits of automation, it may bring other advantages. For example, schemes for car-sharing will be more effective, especially in municipalities and cities, resulting in fewer cars on the road. According to relevant results, there could be ‘a drop’ in ownership of cars. However, this would mean that the yearly mileage of each car would, on average, be double as high as it presently is. This would lead to a higher turnover of vehicles, and therefore no discount in automotive manufacturing. However, this is unimportant compared to “the safety and environmental benefits” of the proposed automated driving system. Although there are some drawbacks, the fact that so many lives are saved makes the future relatively rosy. With self-driving cars, that little joy is lost. In sum, the advantages of self-driving cars far outweigh the disadvantages.

8. Conclusion

A review of related research papers on this topic has also shown that some public authorities have developed procedures for boosting the advantages of driverless cars. It turns out that the focus is on social purposes such as system-wide safety and effectiveness, and management of transportation requirements. At the same time, it was argued that limiting the movement of vehicles to the capacity of the road and supporting high employment compared to low-occupancy vehicles. To conclude, research on this topic can help to analyze driverless vehicles and related services that affect road, parking, and public transport needs. However, it can be a program that answers how to minimize existing or potential problems and maximize overall benefits. This makes it easy to identify the criteria that must be met to move legally on public roads. All in all, this article shows that the advantages of self-driving cars far outweigh the disadvantages. This research opens several future topics of social, economic, and geographical interest in the future of autonomous vehicles and technologies.

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