



Automation and Smart Cities: Opportunity or threat?

A 2getthere white paper

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Automation and Smart Cities: Opportunity or threat?

In short:

- Globally, policy makers think about new urban concepts called Smart Cities.
- In almost all cases, self-driving (electric) cars are part of those concepts.
- Autonomous transport is seen as a key to (1) fewer cars and car movements in the city, (2) less parking pressure and (3) improvement in air quality. In addition, autonomous vehicles are considered (4) to increase road safety greatly.
- However, it is highly questionable whether these benefits derive from self-driving vehicles.
- Less cars and car movements are mainly the effect of car sharing. If autonomous transport leads to people leaving public transport, it could even lead to an increase in the number of cars and car movements.
- Autonomous cars also need to be parked somewhere when they are not being used, and need to stop and park to pick people up. Parking autonomous cars outside the city does not mean two, but four rush hours every day.
- Driving autonomous does not, in itself, help improve air quality. A reduction in carbon is gained with all electronically powered vehicles. The level of this reduction is dependent on the sustainability of the source of the power.
- Autonomous driving only has a positive effect on road safety if all traffic becomes autonomous and the entire infrastructure is organized around it. Until then, driving autonomously will most likely lead to more incidents.
- Conclusion: Automation is an opportunity for Smart Cities when done right, and a threat if not. Done right means: with sustainably sourced electric power and the capacity to transport multiple passengers with partly shared itineraries.



INTRODUCTION

1.1 Introduction

Globally, policy makers are thinking about new urban concepts every day. Partly out of necessity; as traffic congestion, pollution and smog are seriously endangering living conditions and public health. And partly because state-of-the-art technological developments like the Internet of Things and Big Data analysis are providing new opportunities. These new urban concepts are commonly referred to as Smart Cities.

A Smart City is a city where information technology and the Internet of Things are used to manage and control the city. This includes both their administration and the management of facilities such as libraries, hospitals and utilities and, most importantly, the public transportation system.

Different sectors have been working on the Smart City concept in recent years - first and foremost the transport and traffic sector. But local government, health care, dirt management, water management and energy markets are also developing online services and applications that should help to realize a Smart City: A city that is cleaner, safer, more accessible and more attractive to citizens and businesses.

1.2 Smart Cities, Smart Mobility

From the perspective of urban planning for Smart Cities, automated cars are a transformational development that (1) will reduce the number of cars in cities, (2) free up urban space currently used for parking and (3) improve overall sustainability, while at the same time (4) reducing the number of incidents, accidents, injuries and casualties. It's therefore no exaggeration to say that driverless cars have become the default association of Smart Mobility.

However, it is highly questionable whether the above-mentioned benefits arise from driverless cars directly. This starts first and foremost with identifying which advantages are associated with automation and which aren't. In the following sections, we will look critically at these identified and presumed benefits.



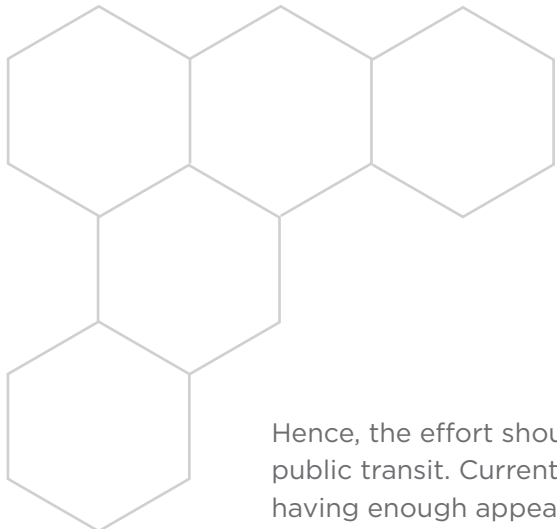
BENEFITS

2.1 Presumed benefit 1: Reducing cars and car movements

Automated cars are stated to reduce the number of cars on the road, the number of car movements and the overall space needed for parking. Yet this is, in fact, an advantage of car sharing, not of automation (Tree hugger, 26 May 2017). As such, driverless vehicles will only be able to achieve a reduction of car movements - if at all - if cars are shared. Which means that they would be on ride-hailing services such as Uber and Lyft with automated cars, or on public transit applications. Public Transport should be the clear preference and, as such, the focus of developers and Smart Cities.

The possibility that new, autonomous vehicles will be able to offer shared rides must be weighed against the significant possibility that large numbers of non-drivers (i.e. current public transit users) may decide to purchase their own autonomous cars. If this happens, cities will be filled with autonomous vehicles with far less total capacity than buses or trains. The focus for Smart Cities needs to be on increasing the efficiency of the number of people transported per hour, not on autonomous vehicles as a single solution.





Hence, the effort should be focused on maximizing the number of people using public transit. Current users must be retained, with new public transit systems having enough appeal to convert current car users. This can only be achieved when you start with public transit solutions not with private, shared vehicles.

Similarly, many analysts envision roving fleets of autonomous, shared smart taxis that will mitigate the need for people to own their own cars. However, this concept will depend on multiple, competing service providers, each with slightly different business models and each operating their own fleets, so empty taxis looking for passengers will always be there. Furthermore, any transport model that can offer rapid, personalized on-demand transit for individuals or small groups will require surplus fleet capacity to answer high demand within a reasonable timeframe.

Due to fluctuating demand, there is likely to remain a surplus of vehicles running in cities. This will only fractionally reduce the total number of cars, while possibly increasing the number of car movements as total number of journeys will not be impacted (Read write, 24 January 2017). Again, through public transit systems, this issue can be addressed. Public transit vehicles that run an on-demand or a high frequency service could provide the backbone of the city's public transport network, with a single public transit agency responsible for the assignment of operating contracts to operators.

2.2 Presumed benefit 2: Freeing up parking space

The idea that driverless vehicles reduce the amount of space required for parking in city centers also faces similar problems. Urban traffic exhibits a near-universal pattern of morning and evening rush hours, together with a slightly busier lunchtime. Even if morning traffic were handled by a theoretically perfect system of autonomous vehicles operating at 100 percent capacity (every vehicle full, no excess fleet capacity available, and all passengers reaching their destinations in the expected timeframe), demand would quickly fall off after the morning rush hour.

As a result, large numbers of autonomous vehicles would still need to be parked somewhere, or would continue circling the city without passengers. If parking spaces in city centers were eliminated, the vehicles would need to exit the city center to be parked elsewhere – only to drive back into the city to transport passengers for the evening rush hour. Instead of two daily movements in and out of the city for each vehicle, we would have four, which hardly contributes to decreased energy use and increased sustainability. Larger, shared vehicles that can accommodate 25 or 30 passengers – would allow for the number of cars and car movements to be reduced, while also reducing the number of parking places (Vox, 18 May 2017).

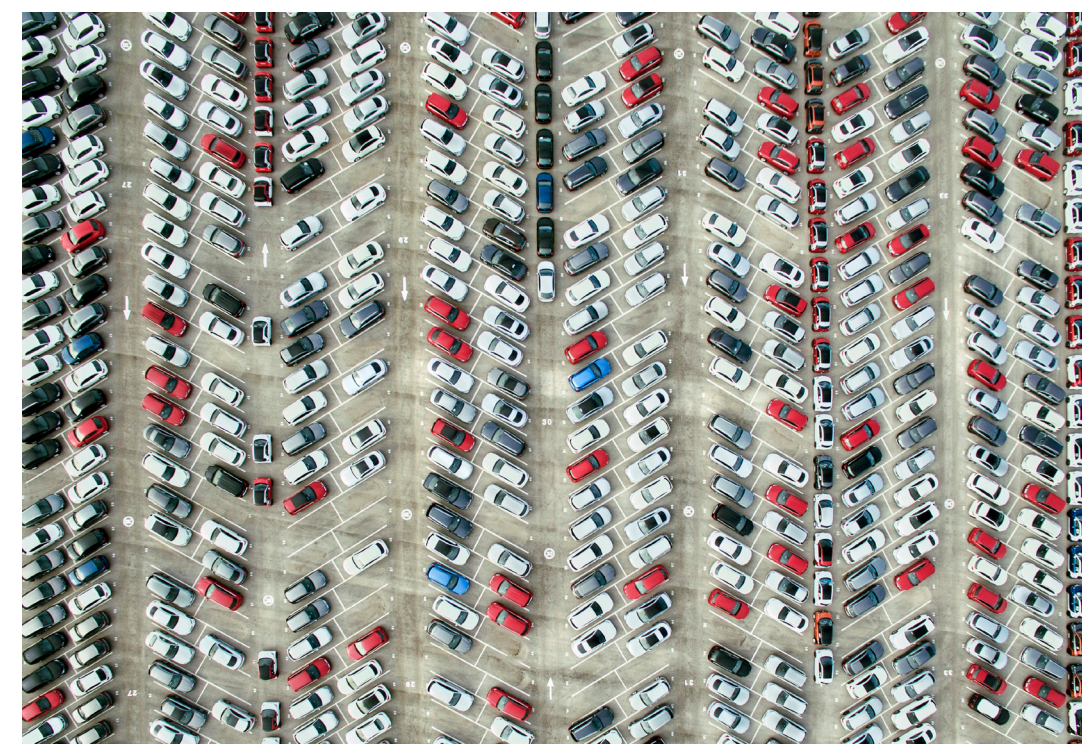
Even in a city with an infrastructure based solely on autonomous vehicles,

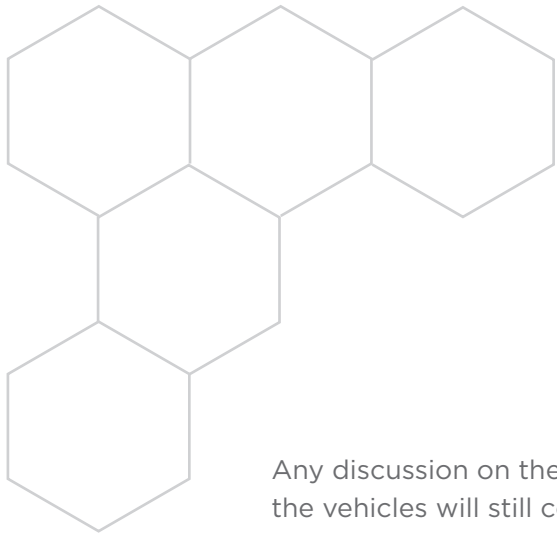


parking will be required for a different function: picking up and dropping off passengers. This needs to be in a position that does not hinder ongoing traffic, so either designated stations (which is not the preference) or a continuous 'maneuvering' lane. A maneuvering lane would pick up passengers from any location, based on the coordinates of their cell-phone which would be used to request the transit vehicle.

Although this might seem exaggerated, imagine a single lane in rush hour with vehicles every 4 seconds: you have just reserved transportation which has stopped to pick you up, when your colleague approaches you, you run into an old friend or get that important call you have been waiting for all day. How much does that slow you down? How long does the vehicle wait for you before it continues? Continuing without you is wasting capacity and will require a larger fleet to handle everybody at peak periods and this fleet needs to be parked when not active.

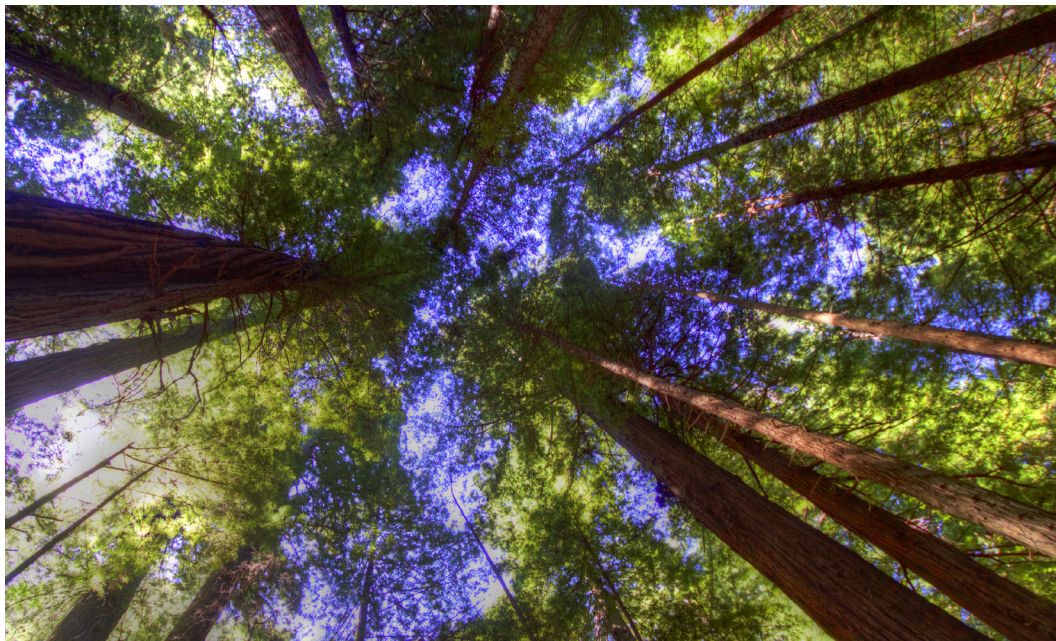
Parking places may be renamed pickup points, but it is highly debatable whether a radical reduction of parking spaces would reduce space consumed by cars in city centers unless the 'old-fashioned' concept of stations is re-introduced. As the station concept is derived from public transportation, why then switch from public transportation, as it will be the same system, just with a different vehicle. Public transit systems should be the focus of developers and cities, with the (autonomous) car only used to serve the breadcrumbs remaining.





Any discussion on the sustainability of automated vehicles must consider that the vehicles will still consume energy, and the way this energy is generated. An automated vehicle will only reduce exhaust emissions if it is electric (to date all demonstrations have used electricity as a power source, which is not a requirement, but the choice of the demonstrator). And even though the vehicle might be electric, having the energy generated in a coal power plant only makes the cars zero-emission a point of use in cities, where you have high levels of population density. For city planners, vehicle manufacturers and individual drivers, the choice of electric vehicles may turn emissions into a comfortable externality, something that is just not your responsibility. As a society, we need to be able to look further into this, to understand the levels of emissions produced at source and at the point of use.

Energy consumption per user can be reduced by technological improvements, but the single largest effect will be the increase of ridership. Where the average car holds just 1.1 to 1.3 passengers per vehicle during rush hour, they are even less efficient in off-peak hours because they will be on the streets continuously in search of new passengers (which can be avoided with paid parking). This problem is exacerbated with large public transit units as they are used to move only small number of passengers in off-peak periods. Neither scenario is desirable when trying to minimize energy consumption. Taking the middle ground may make more sense, with smaller sized group-oriented vehicles providing a significant capacity during peak hours, while being able to run an on-demand service in off peak periods. This would help to optimize energy usage throughout the day and maintain a low cost per user.



2.4 Presumed benefit 4: Reducing the number of incidents, accidents, injuries and casualties

Questions of safety are always top of mind when thinking about self-driving cars (Advertising Age, 18 April 2017). As we are sometimes not the best drivers, it is often thought and stated that automation is safer and will lead to a reduction in the total number of incidents, accidents, injuries and casualties.

Nowadays, many cars already incorporate advanced driver assistance functions. Older and more basic functions include ESP, ABS and navigation systems, while more recent advanced systems for ACC, CACC, automated lane keeping and automatic braking when the car detects an obstacle in its pathway are now becoming more commonplace. One could state that the Tesla system, inappropriately named ‘autopilot’, is in fact an advanced driver assistance system.

While such systems are designed to improve safety, they may make the roads a little less safe. Firstly, the systems need to avoid false positives. Drivers have reported cases where their vehicle performed an unnecessary emergency braking procedure due to another car executing a quick lane change in front of them. This is a situation that a human driver can easily anticipate as non-threatening, but computers do not have this capability – at least not yet.

Secondly, the systems may decrease safety levels by being safer than other cars on the road. An automated car is more likely to detect an event in time and respond appropriately than a human, who has a longer ‘delay’ between registering the actual event and taking appropriate action (Driver’s Alert, 22 December 2016). This could possibly result in vehicles with advanced driver assistance systems being rear-ended more often, as they brake quicker and harder than a human driver typically would or could.

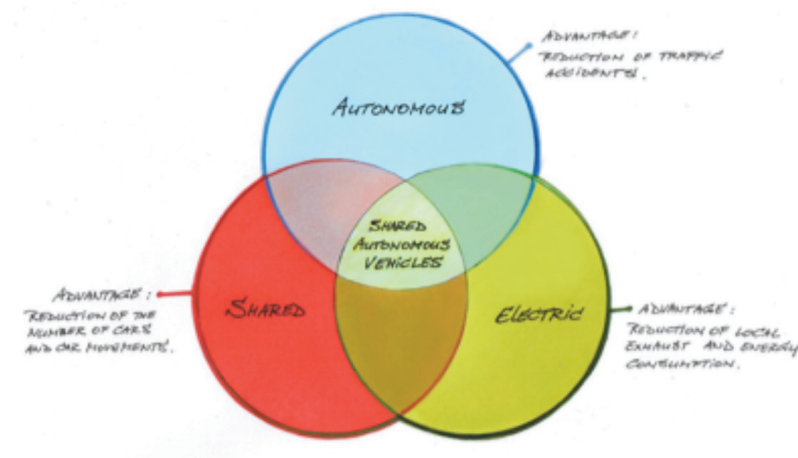
From this we can conclude that reducing incidents, accidents, injuries and casualties will only be realized when most cars are autonomous. Until this time, these advantages will only be achieved in “autonomous vehicles only” zones. As with many advances in car technology, we’ll see this technology feature in the high-end models first and slowly trickle down to cars that most people can afford. Taking into account the average actual life of a car, of 12-14 years, it will take decades before most cars on the road are equipped with the latest automated driving systems.

Any major gains in safety will only be realized if all vehicles are under a unified fleet management system that optimizes the performance of the entire fleet on a global level. For example, certain traffic corridors may need to be stopped temporarily to provide maximum throughput on another, thus optimizing performance as a whole. While one part of the industry is actively working on this, the people working on the development of the vehicles themselves aren’t. Integration between them will be necessary to achieve the best results.

CONCLUSION

3.1 Conclusion

When autonomous vehicles are combined with electric power and the capacity to transport multiple passengers with partially shared itineraries, the benefits for Smart Cities are clear.



At the same time, we can easily conclude that automation is an opportunity for Smart Cities only when done correctly, and a threat if not.

From the logistical perspective, there are very strong arguments against the common claim that autonomous vehicles will lead to a significant reduction in the total number of road vehicles. It is possible, but it will require the entire system to be configured so passengers are effectively forced to share vehicles and use predefined transport hubs (e-architect, 10 November 2016). However, this kind of model ceases to be a system of autonomous vehicles and becomes, an automated public transport system who's success is dependent on individual's access to autonomous vehicles being restricted.

In the end, the most important thing is to discourage people from using a personal car and to start using public transit. Not only due to their logistical impact, but because public transit systems are intrinsically safer than cars – even autonomous cars. Autonomous cars will reduce the number of injuries and casualties amongst current car users, but if we increase the number of users by

making autonomous cars more attractive than public transit, we as society will not experience the full benefit.

Finally, in public discussion and industry debate on automated vehicles, the concepts of automated, shared, and electric are often confused. The automated vehicle doesn't reduce the amount of cars, ride-sharing does. It won't make the city more sustainable, only electricity from a sustainable power source will. This is recognized by UITP in their publication, 'Position Brief'¹.

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About the authors

Sjoerd van der Zwaan (Chief Technology Officer) and **Robbert Lohmann** (Chief Operations Officer) are part of the management team of 2getthere, a company developing, marketing and delivering automated transit systems since 1997. The systems are based on 30+ years of technological development and experience with automated vehicles in various demanding environments – ranging from factories, to ports and urban developments.

The views and arguments presented in this paper are based on their experience delivering automated vehicle systems at several locations around the world. However, these views are solely those of the authors, and may differ from those of other companies and experts operating in the field.

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