

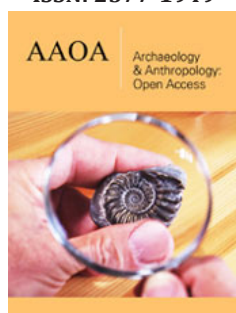
## Unintended Consequences of Automobility – Will Autonomous Vehicles be any Different?

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### Opinion

Accessibility and mobility issues are implicit in all aspects of human development. Mobility systems facilitate access and participation of citizens in social, economic, cultural and political processes. As such, human mobility systems change with respect to the sociocultural and economic structures in which they exist and operate. Until the mid-19th century, all cities were car-free, and walking was the main mode of transportation. Cities during this period were characterized by high population densities, mixed land use, and narrow streets that allowed access principally by walking [1]. This land use pattern originally made it possible to reach majority of destinations by walking or utilizing other slow modes of transport. Schools, places of worship, health centers, markets, and other services were all within walking distance. Economic modernization, however, has come with the proliferation of automobiles and people have been forced off the streets [2]. Rapid urbanization, motorization, and globalization have influenced the desire to achieve higher mobility and increased accessibility, as these are intricately linked with socioeconomic progress [3-5]. Motorized transport has broadened the ability to reach distant places in easier and faster forms than ever before and has influenced travel behaviors in contemporary societies. Automobile transport, especially, has provided “unprecedented” mobility, and seemingly fits in perfectly with the visions of modernity and progress [6]. Whitelegg [7], cited in Urry [8], defined automobility as “the predominant global form of ‘quasi-private’ mobility that subordinates other mobilities of walking, cycling, travelling by rail and so on, and reorganizes how people negotiate the opportunities for, and constraints upon, work, family life, childhood, leisure and pleasure”. The automobile has offered “freedom” in space and time to live anywhere and get quickly to all destinations regardless of location [1]. However, according to Urry [8], “automobility has extended individual freedom and flexibility, but has constrained “car users” to live their lives in spatially stretched and time compressed ways. The car is the literal “iron cage” of modernity, motorized, moving and domestic.”

Most cities today, since the advent of cars, have been built around the needs of the automobile and not the people, thus, roadways have been designed to meet the requirements of vehicles. Indeed, Newman & Kenworthy [1] suggest that a city’s mobility characteristics have evolved with each new dominant technology. Needless to say, the auto-dependency syndrome has altered the transport-land use pattern in a more dramatic way than probably anticipated. The automobility paradigm has led to making changes to where and how people live [6,9,10]. Compact, walkable, and socially integrated cities have expanded beyond their boundaries in the very short period of the existence of automobiles to reflect the so-called modernity. Socioeconomic activities in this “modern” society exhibit spatiotemporal features (trip origins and destinations increasingly being separated from each other in space and time) that necessitate some form of fast mobility. Case in point, a person’s home and place of employment in present day are widely separated, and inflexible working hours are set in strictly defined work locations. Lucas [11] observed that providers of key services, including employers, have failed to recognize the role of transport in the distribution of the ‘merit good’ of their services. She argues that this has resulted in a situation where, increasingly, essential services such as jobs are in places that are virtually impossible to access without a car. This era of automobility has helped to bridge the gap between economic activities and social groups that are wide apart but has weakened community cohesion and cultures.

With the rising automobile dependency, traffic crashes, pollution and traffic gridlocks have become defining characteristics of many rapidly urbanizing and motorizing cities across the globe. As an unintended consequence of automobility, an estimated 90% of all road fatalities are attributed to human errors and behaviors such as speeding, drunk driving and distractions occurring within and outside the vehicle. Global statistics reveal that nearly 1.3 million people are killed through road accidents every year [12]. In addition, cities have expanded to a point where travel times are generally increasing, and many more people are trapped in traffic gridlocks on a daily basis. For instance, with the current trends, a US citizen by 2050 will on an average suffer more than 100 hours of congestion-related delays a year [13]. Travel times in developing nation cities are also increasing in spite of their current low motorization. Traffic congestion threatens the accessibility of economic centers as the expansion of mobility puts mobility itself at risk [3]. Without major mobility and accessibility improvements, many rapidly growing cities will face traffic and economic gridlock. The role of transport systems in human development will therefore be crucial in shaping urban form and the way of life, as some 50 percent of the world population is expected to be city dwellers by 2030 [14].

The coming years promise some potentially drastic changes in personal mobility, including the use of Autonomous Vehicles (AVs), and the possibility of replacing individually owned vehicles with "Mobility as a Service" (MaaS) options such as shared AVs. AVs or self-driving cars will be equipped with sensors and cameras to perceive their surroundings and have the capability to drive themselves, with little or no human input. Connected vehicle technologies will allow vehicles to communicate with each other and the infrastructure elements that make up the transport system. Some of the current vehicles are semi-autonomous, with Advanced Driver Assistance Systems (ADAS). These systems make up for some of the driver limitations that contribute to road crashes and help improve the overall highway safety. With full automation, no human input will be required. Full automation is nearing its realization in society. When they are fully deployed, AVs promise to be the most far-reaching advancement in human mobility since the invention of the automobile. In December 2018, Google offshoot Waymo became the first to commercialize a fully autonomous taxi service in the U.S. However, many automakers and tech companies agree that the deployment of fully AVs is not possible before 2035 or even 2050. In spite of that, a large body of studies has been dedicated to exploring the potential challenges and benefits of AVs. What is certain is that AVs will change how people live, work, and get around in the near future. According to the Boston Consulting Group, if AVs are to affect urban life significantly, car sharing almost certainly has to be part of the deal.

However, just like the traditional automobile, AVs are expected to produce some unintended consequences during the transition phase, and when they are fully deployed. So far, it is not very explicit

if the ease of use of AVs will lead to an increase in car ownership and use, and further continue the process of urban sprawl as well as potentially increase traffic congestion in cities, or if shared autonomous vehicles will lead to a reduction in use and eventual ownership of cars. For instance, while many industry players believe that shared autonomous vehicles will reduce vehicle ownership, researchers at McKinsey & Company suggest that shared mobility may be unattractive for multi-stop trips such as shopping stops, and the potential of "uncomfortable dynamics among people who are basically strangers" would mean that many more people would likely want to own cars. On the flip side, the use of automated vehicles for delivery of goods will transform the retail industry, as shopping trips will be significantly reduced. These scenarios will have far reaching consequences for the human society. While many transportation infrastructural changes will have to be made before full deployment of AVs, this is not expected to immediately affect where people live and work. With changes to the transportation infrastructure and all vehicles being autonomous, the section of the population that love to drive recreationally will be missing out while people who hitherto have restricted mobility due to conditions such as age and disability, or even considered driving risks will have access to vehicles for their travel activities. AVs are expected to take away manual driving controls from humans, which would eradicate all fatalities involving human error and behaviors. However, with AVs, there is always the possibility crashes due to glitches in the system. Since these vehicles will rely heavily on computers, they will be susceptible to hackers and cyber threats. Also, AVs will pose a new threat to global security. The 21<sup>st</sup> century has witnessed over a dozen of terror attacks involving vehicles used as deadly weapons, killing many and injuring many more. In 2010, the Federal Bureau of Investigation (FBI) and Department of Homeland Security (DHS) reported that: "terrorists overseas have suggested conducting vehicle ramming attacks-using modified or unmodified vehicles-against crowds, buildings, and other vehicles. Such attacks could target locations where large numbers of people congregate, including parades and other celebratory gatherings, sporting events, entertainment venues, or shopping centers. Vehicle-ramming attacks are considered unsophisticated, in that a perpetrator could carry out such an attack with minimal planning and training". This unintended consequence of the human-driven automobile is expected to be transferred to the AV. There is potential that terror groups will weaponized AV technology to carry out attacks. This and other challenges will have to be taken into consideration before full deployment, while avoiding the temptation to restrict the individual freedoms of AV owners. Ultimately, it is obvious that like human-driven automobiles, AVs will present a set of unforeseen problems when they are fully deployed.

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