# Impacts of Autonomous Driving on Public Transport Services

## (Extended Abstract)

**Joachim R. Daduna**
Berlin school of Economics and Law
Badensche Str, 52, 10715 Berlin, Germany
Phone: +49 30 30877 1114, e-mail: daduna@hwr-berlin.de

### Introduction

The technological basics of road vehicles were and still are essentially up to now mechanized vehicles that have to be steered and controlled by people. However, the development of information technology during the last years has led to significant effects. Initially, the focus was on increasing vehicle performance as well as on improving safety. But with an ever-increasing digitization, the age-old dream of driverless vehicles returned to the awareness of peoples.

In the meantime, it is no longer just a dream, the first autonomous vehicles are approved for use in public street networks. This opens completely new possibilities for the design of service offerings for (public) passenger transport as well as for freight transport. Thus, the previously required by law steering a vehicle by a driver will no longer exist. Substantial other restrictions are canceled, especially in labor law. There are no more restrictions on working hours and there is no need for driving period or break period regulations. At the end, a use of vehicles over the entire day and over all days of the week is possible without restrictions, apart from maintenance and repair times.

The more efficient use of vehicles and the elimination of personnel costs will not only increase efficiency but also lead to additional benefits. Since autonomous vehicles eliminate the individual driving behavior of people, it will lead to savings in energy consumption and thus also to reductions in transport-related emissions. Moreover, considering that road traffic accidents are predominantly based on human errors (in Germany, for example, 93.5%), the extent of the achievable positive effects can be anticipated. Here not only the costs of the accident-damaged vehicles must be seen but in particular the costs of personal injuries and the long-term negative financial impacts on public health care costs. Overall, it is clear that from an operational point of view and relating to societal aspects, the use of driverless vehicles show significant advantages. In the following it should be considered to what extent these advantages can be used in new forms of public passenger transport services.

### Autonomous vehicles in urban areas

Due to population density and limited traffic area, the traditional rail-based transport systems and bus systems will continue to be in the foreground, but in the future they will be operated autonomously. In addition, with the help of smaller vehicles, such as autonomous cars and minibuses, the services can be extended. Different areas of application are possible:

- Passenger transport on the "last mile", for example, between a train station or bus stop of higher-level transport systems and private residences.
- Local access of inner city neighborhoods in connection with shopping and tourist activities.
- Internal transport development of a spatially limited facility areas, such as large-scale hospital and university sites.
- Enabling a time-limited individual mobility.
- Substitution of standard services, for example in peripheral areas and in times of very low demand (at night and on weekends).

Different vehicle systems can be used to implement these concepts:

- *Autonomous taxis*: These are primarily for use on the "last mile" (such as RoboTaxis running in Singapore).
- *Car-sharing*: This service is also an approach for passenger transport on the "last mile", but it primarily allows an individual mobility without having own vehicles.
- *Mini-buses*: These transport systems are suitable as supplementary services in peripheral areas and as a substitutional option during off-peak hours, for example, as a cost-effective service during the night. In addition, different forms of services are possible in inner-city neighborhoods, tourist areas and traffic-calmed residential areas as well as in closed areas with large-scale structures (for example hospital and university areas).

**Autonomous vehicles in rural areas**

In rural areas, public transport is essentially limited to regional rail and bus services as well as school bus traffic. The focus is therefore on reducing the undersupply that exists in most cases, whereby quantitative as well as qualitative improvements are the objectives.

- An important measurement is the establishment and expansion of local public transport services to ensure a basic mobility. In the foreground is a clear extension of service periods and a stronger demand orientation.
- Development of improved and demand-based service forms to connect local services to regional transport networks.
- Improvement of school bus traffic through a stronger focus on demand structures, especially regarding to time-related aspects.

Again, the different vehicle systems can be used to implement these concepts:

- *Autonomous taxis and car-sharing vehicles*: Development of demand-oriented services in the local area, for example to form efficient connections to higher-level public transport networks. However, a mandatory prerequisite for the integration of car-sharing offers is a station-independent concept. In addition, under these conditions, car-sharing enables the provision of a temporary individual mobility, even in rural areas.
- *Mini-buses*: Due to the demand structures, it is possible to provide timetable-based line services in local areas. However, there is also a use as line taxis in different demand-oriented operating forms. These are line corridor operations as well as flexible area-based demand-response transport services, whereby in both cases a centrally organized planning as well as monitoring and control is the prerequisite. Here also school bus services can be integrated.

## Outlook

This brief overview shows that there are many design options for urban and rural areas in order to improve and expand mobility services through the use of autonomous vehicles. Linked with these measurements are significant cost savings, which in many cases only make it possible to realize these outlined additional services. In the case of using vehicles with e-traction, also positive environmental effects can be achieved, especially in urban areas.

A basic prerequisite for the functioning of the technical processes is a public transport provider-wide management of the services with a coordination based on real-time information. At the same time, interactive communication between the operations control centers and customers must be possible in order to react to short-term deviations. In addition for servicing short-term demand, however, it must also be possible to book in advance plannable rides.