Transport Policy 61 (2018) 106–110

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Passenger's subjective traffic safety, in-vehicle security and emergency management in the driverless shuttle bus in Finland

Arto O. Salonen

Metropolia University of Applied Sciences, PO Box 4000, FI-00079 Metropolia, Finland

ARTICLE INFO

Keywords:
Driverless shuttle bus
Autonomous vehicle
Public transport
User experiences
In-vehicle security
Traffic safety

ABSTRACT

Mobility services are evolving globally. Driverless public transport can be a game-changer for urban mobility. However, empirical evidence from the point of user experiences is lacking. A customer's sense of safety and security has a significant influence on public transport acceptance. This case study focuses on driverless shuttle bus passengers' subjective experiences of (a) traffic safety, (b) in-vehicle security, and (c) emergency management compared to the conventional bus. Data were collected through interviews from informants that travelled by driverless shuttle busses in the City of Vantaa, Finland in summer 2015. A total of 19,021 passengers travelled by 3,962 km autonomous buses on a specific route. The sample of 197 informants was analysed by quantitative methods. Informants assessed perception of traffic safety to be better in the driverless shuttle bus than in a conventional bus with a driver. However, they were lacking personal in-vehicle security. 64 per cent of passengers answered that sense of in-vehicle security in the driverless shuttle bus was worse or much worse than in the conventional bus. There was a significant difference between women and men when they evaluated their subjective sense of security on board $F(1, 195) = 8.196$, $p < 0.001$. Men assessed their experiences of traffic safety, in-vehicle security and emergency management to be overall better than those of women. In order to mainstream the use of driverless shuttle buses, for example as a part of a transport chain, traffic safety is not a problem. Instead, a passenger's sense of security on board should be increased. This is the case especially with female passengers.

1. Background

Mobility is evolving globally. Travellers show an increasing willingness to combine multiple modes of transport. People are moving from ownership to usership. Vehicles are more often replaced by trouble-free access and good availability of mobility. In the United Kingdom, the decline in car travel was partly, and in Germany fully, compensated by an increased use of alternative modes of transport (Kuhnimhof et al., 2012a.). In Stockholm, Sweden, only one in ten 18-year-olds gets a driving licence (Aretun and Nordbakke, 2014). In the USA, nearly one in five young adults do not have a driver's licence (Department of Transportation, 2017; also Klein and Smart, 2017). This trend is also identified in Helsinki, Finland (Brandt and Lindeqvist, 2016).

Self-driving cars will be introduced to customers in various countries in 2018–2022 (Shanke et al., 2013, 37–44). After 2040, the majority of the cars sold in the United States will be driverless cars (Corwin et al., 2016). Conventional public transport, with its high capacity, is set to remain the transport backbone of cities. It reduces traffic congestion, which increases public interest in the provision of convenient and affordable mass transit services. Autonomous buses can cover distances that are too short to travel by car or are too long on foot (UITP, 2017). Traffic safety and reduction in congestion "contain values that allow consumers to advertise themselves as safe, smart and prosocial" (Shariff et al., 2017).

Passengers are real consumers of mobility services. An average European spends ten days a year in a car (Penn Schoen Berland, 2016). Knowing and understanding the customer is a major challenge for the whole transport industry, government and academia. A detailed understanding of the determinants of travel mode choice and the adaptation of innovative multimodal solutions is required (Beecroft and Pangbourne, 2015). Subjective perceptions of passengers are fundamental for assessing the performance of services. A positive user experience is a core thing in customer engagement, which is based on internal cognition and emotion (Higgins and Trope, 1990).

Perceptions of customers' traffic safety and in-vehicle security have a significant influence on public transport acceptance (Delbosc and Currie, 2012). Subjective traffic safety refers to fear of accident while subjective in-vehicle security refers to fear of crime (Houshmand and Fastenmeier, 2015; Beecroft and Pangbourne, 2014). Empirical evidence from Norway shows that good perceptions of traffic safety and in-vehicle security are

E-mail address: arto.salonen@metropolia.fi.

https://doi.org/10.1016/j.tranpol.2017.10.011
Received 25 April 2017; Received in revised form 5 October 2017; Accepted 24 October 2017

positive predictors of intention to use public transportation (Şimşekoğlu et al., 2015; Nordfjærna et al., 2015). An analysis of influences on satisfaction with bus journeys in Edinburgh, UK found that in-vehicle security was the most commonly cited concern (Stradling et al., 2007). Moreover, in Milan, Italy, traffic safety and security on board were the most important factors of public transport services (Eboli and Mazzulla, 2012). Costs and time efficiency also play a major role (Clauss and Döppe, 2013).

Autonomous public transport can be a dynamo in developing multimodal mobility systems. Innovative mobility solutions could be a valuable starting point for firms and policy makers to create new business models and services (Corwin et al., 2015). However, more understanding of the adaptation of new solutions is needed (Kuhnimhof et al., 2012a, 2012b) and lack of empirical evidence from the users of autonomous public transport is evident. Therefore, in this research we focus on self-driving public transport services. We are interested in knowing how passengers assess their subjective experiences straight after they have travelled as a passenger in an driverless shuttle bus. This approach combines both cognition and emotion of the passenger (e.g. Svenonius, 2011).

2. Safety and security of public transport

A discourse of 'security as emotion' is rising. Perceptions about traffic safety and trust in other passengers are essential factors of successful public transport. Security as emotion concentrates the central role that surveillance and private policing assumes as the security policy shifts objectives to subjective feelings of the passengers (Svenonius, 2011). Feeling safe and secure on mass transport is positively related to frequency of public transport use. Studies in the UK suggest that 10 per cent of the population would reconsider using public transport if their fears were addressed (Crime Concern, 2004). In Melbourne, Australia, feelings of security had a small but significant positive influence on how frequently people used public transport (Delbosc and Currie, 2012).

What we already know is that the level of trust in the technology of self-driving vehicles varies (J.D.Power, 2017). It is not easy to trust a driverless vehicle. Most Americans seem to be leery of self-driving cars. 78 per cent of them report that they fear riding in an autonomous vehicle (Brannon, 2017). Moreover 84 per cent of people across the UK, France, Germany, Norway and Spain are less willing to trust their loved ones to technology (Penn Schoen Berland, 2016). However, it is notable, that these results are based on preconceptions of the informants. They did not have a real riding experience. In this research we focus on passengers' authentic experiences of (a) traffic safety, (b) in-vehicle security, and (c) emergency management in the context of driverless shuttle buses.

Traffic safety refers to risks outside of the vehicle such as the possibility of being involved in a traffic accident. 1.2 million people around the world die each year in traffic accidents. 90 per cent of traffic accidents are due to human error (UITP, 2017). A smooth combining of self-driving cars and seamless public transport can reduce the number of cars by 90 per cent (OECD, 2016; PriceWaterhouseCoopers, 2013) and eliminate traffic accidents almost totally (Singh, 2015; Fagnant and Kockelman, 2015).

In-vehicle security is related to antisocial behaviour, for example, the possibility of becoming a victim of crime inside in a vehicle (Beecroft and Pangbourne, 2015; Eboli and Mazzulla, 2011). Fear of crime and a perceived sense of being insecure have the potential to discourage individuals from using public transport (Transport for London, 2011). It is likely to have a greater impact on individuals' perceptions of the security of public transport than terrorism (Beecroft et al., 2007).

Emergency management refers to the unexpected events associated with both safety (indoor) and security (outdoor) when travelling. When emergency management is good, passengers can efficiently detect, prioritise and respond as incidents occur. They feel, for example, that they are able to use emergency exits, fire alarm systems and channels for reporting anything suspicious they may see or even hear on board. Thus, emergency management includes technologies that are available and which can be used to combat risks.

As compared to conventional bus travel, this research covers passengers' experiences when travelling in a driverless shuttle bus. Our research questions are:

(a) How do passengers assess their perception of *traffic safety* experienced in the driverless shuttle bus?
(b) How do passengers evaluate their perception of *in-vehicle security* experienced in the driverless shuttle bus in terms of fear of violence?
(c) How do passengers evaluate their perception of *emergency management* in the driverless shuttle bus?

In addition, we are interested in finding out what kinds of differences are there in the sense of traffic safety, in-vehicle security and emergency management in the driverless shuttle bus when comparing results between gender, age, education, net incomes and employment status?

3. Material and methods

The data were collected in the City of Vantaa during the Housing Fair 2015, the biggest annual summer event in Finland. A total of 19,021 passengers travelled 3,962 km by EasyMile EZ-10 driverless buses between July 10 and August 9, 2015. The pilot scheme was carried out as a part of the CityMobil2 project (McDonald et al., 2015).

The data is a discretionary sample. Our informants were passengers who travelled from Kivistö Railway Station to the Exhibition Centre or the same journey in reverse by the driverless shuttle bus. The interviews with passengers were carried out straight after they came out of the self-driving autonomous bus.

The length of the route was 950 m including an approximately 100-m-long tunnel. Three vehicles operated on the route without multiple time points of rider onboarding and exiting. The carrying capacity of each driverless shuttle bus was 10 passengers (6 seats and 4 standing passengers). The average number of passengers in a bus was 4.8. The maximum speed of the vehicle was adjusted to 13 km/h. The route was segregated from all other traffic. A member of the research group was on board at all times (McDonald et al., 2015).

The demonstration proceeded without accidents. However, there were 52 emergency stops during the demonstration. Stops occurred on average 1.7 times per one hundred kilometres. Most of the stops were due to freezing of the software, but vehicles also lost their location 16 times during the 3962-km demonstration (McDonald et al., 2015).

Safety, security and emergency management have both subjective and objective dimensions. The objective dimension refers to the statistical risks while the subjective dimension varies according to one's personality (Ceccato, 2013). In this research we focus on the subjective dimension. The study design is illustrated in Table 1.

Informants (n = 197) were asked to assess their perceptions of traffic safety, in-vehicle security and emergency management in the driverless shuttle bus compared to a conventional bus travelling on the same route and in the same traffic conditions. The comparison to the conventional human-driven bus on the same route was hypothetical. A scale for the assessments was 1 = much worse, 2 = worse, 3 = equal, 4 = better, and 5 = much better than travelling with a conventional bus. Gender and age are commonly-cited influences on perceptions of personal safety and security in public transport (Delbosc and Currie, 2012). Thus, we use gender and age as socio-demographic characteristics of the sample. We

Table 1
The study design combines different elements of passenger's subjective perceptions on safety and security outside and inside of the vehicle.

Subjective traffic safety (outdoor)	Subjective in-vehicle security (indoor)
Emergency management (indoor + outdoor)	