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Seat belt usage in buses – An observation study of usage and travellers' perspectives

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ABSTRACT

This study aims to evaluate seat belt usage in buses and to understand travellers' incentives of seat belt usage. Methods used are observational studies (10 cities, with 328 bus observations), focus group discussion (7 groups with a total of 32 participants) and a web survey (n = 1737 respondents). The results show that the seat belt use among bus passengers can be improved especially in regional and commercial bus traffic. It is more common to buckle up on long trips than on short trips. However, even though observations show high usage during long trips, travellers report that they remove the seat belt after a while if they want to sleep or for comfort reasons. For the bus drivers it is not possible to control passengers' usage. Dirty seat belts and technical malfunction might deter some passengers from using them and therefore systematic cleaning and control of seats and belts are recommended. On short trips one reason for not using the belt is related to worries about getting stuck and not being ready to get off in time. In general, it is most important to increase the usage on high-speed roads (>60 km/h), in lower speed it might be more important to provide a seat for each passenger. Based on the results a list of recommendations is presented.

1. Introduction

Travelling by bus is one of the safest modes of transport (Albertsson et al., 2006). However, crashes still happen, and studies have found that the most severe crashes are related to rollovers, mainly on rural roads (Albertsson and Falkmer, 2005). In a rollover crash the risk of suffering severe injuries is greater if the passengers do not use seatbelt (Albertsson and Falkmer, 2005; Guler et al., 2015). The most severe injuries occur when unbuckled passengers are thrown out through the windows or get stuck under the bus. In the literature review by Albertsson and Falkmer (2005) the authors concluded that in relation to safety going by bus the following are important to know:

- Women more often travelled by bus compared to men, and injuries mainly affected women who were 60 years of age or older.
- Bus fatalities accounted for only 0.3–0.5% of all traffic crashes.
- Fatalities were most common on rural roads, although a large number of all bus accidents occurred on municipal streets.
- Boarding and disembarking the bus caused about a third of all cases with injuries.
- "Rollovers" occurred in almost all cases of serious accidents.
- The preferred seat belt is the 3-point belt.
- Being ejected from the bus is the most dangerous mechanism of injury in bus accidents.

Surprisingly, the use of seatbelts in buses has not been studied in detail the last 15 years, but it is reasonable to belief that the data found in Albertsson and Falkmer (2005) is still relevant.

According to EU legislation all vehicles carrying passengers must comply with several technical requirements (United Nations, 2017)[1]. For instance, within the EU the so called 'M-definition', from M_1 to M_3, include all road vehicles with four or more wheels designed to carry passengers under a common classification. M_1 are described as vehicles that carries passengers comprising not more than eight seats, in addition to the driver's seat. M_2 are vehicles with more than eight seating and a mass not exceeding 5 tonnes, M_3 are like M_2 vehicles but exceed 5 tonnes. Both M_1 and M_2 allow for standing passengers, whilst this is not the case with M_3 vehicles. The M-definitions are also divided into classes

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(I–III) depending on field of application. M_2 or M_3 vehicles class I do not need to be equipped with seat belts whereas for class II seat belts are most often installed on all the seats. However, it is only mandatory with anchoring points from a regulation perspective. Class III vehicles are designed for seated passengers only and here all seats need to be equipped with a seat belt.

Except from travelling with a coach (M_3), often used for charter traffic, it is difficult for a passenger to know what type of vehicle they will travel with. Even if they travel the same route every day the vehicle type might differ, sometimes they might have to stand, other times be seated with a seat belt. How this effects their seat belt usage behaviour is not known. Although, it is quite likely that traveling with different vehicle types would prevent the formation of a habit, a factor closely linked to seat belt usage (Durbin et al., 2015; Şimşekoğlu and Lajunen, 2008).

In Sweden the use of a seat belt and information about usage when traveling by bus is regulated in Traffic Ordinance (1998: 1276) Chapter 4 §10a). In short, all bus passengers three years or older should be seated in a place with a seat belt, if there is such a place, and should use the belt. If there is no seat belt available, it is allowed to stand in the bus (if the bus is approved for standing places). The legal responsibility to inform and make sure passengers under 15 use the belt are on the bus driver. Despite existing regulations there is no clear view on the usage rate of seat belts in buses, or on the travellers' view of their own usage and the reasons to not buckle up. In addition, it is not known the frequency of drivers who inform passengers to 'buckle up'.

The use of seat belt is not always the case when going by bus. Factors considered important for understanding seat belt use in buses includes: passenger's age and gender, origin and destination, time of day during the travel, the presence of a reminder in the form of a sign, badge or similar, if the driver has actively indicated that a seat belt should be worn and which seat one chooses to sit on (Mehta and Lou, 2013). Other identified factors are related to the perception of safety benefits and usability of the belt. For instance, increased usage has been linked to a belief that the belt protects them if they are involved in a crash (Nambulee et al., 2019; Şimşekoğlu and Lajunen, 2008). Factors concerning usability is related to comfort, that is how comfortable the seat belt is to use. If it feels uncomfortable then the passengers are less likely to use it (Jermakian and Weast, 2018; Kidd et al., 2014; Shaaban, 2019; Şimşekoğlu and Lajunen, 2008).

This study aims to evaluate seat belt usage in buses and to understand travellers' incentives of seat belt usage.

2. Materials and methods

This study was performed in 2018 in Sweden. All the technical details are reported in (Anund et al., 2018).

Methods used are observational studies (10 cities, with 328 bus observations), focus group discussion (7 groups with a total of 32 participants) and a web survey (n = 1737 respondents).

By combining both quantitative and qualitative methods, we get a more nuanced understanding of the issues, which can also inform policy and practice. The use of a mixed-method approach also enhances the validity and reliability of the findings (Bryman, 2011). In addition, by using both quantitative and qualitative methods, we can cross-validate the results, increasing confidence in the findings' accuracy.

For the observational study, 10 cities were selected from a sample of 23 Swedish cities used for the annual measurements of speed in urban environment. The selected cities were distributed across Sweden, from north to south and east to west, including both large and midsize cities. The 328 bus observations were conducted in June 2018 and on buses of category M_2 and M_3 - class II and class III. All buses were required to provide seat belts for all passengers. On all the buses the number of belted and non-belted passengers were recorded. Buses observed included: regional buses (78%), commercial buses (19%) and charter buses (3%).

Regional bus traffic refers to route-based bus operation that the regional public transport authorities (RKM) are responsible for. This includes city buses and buses between two or more urban areas. The traffic is conducted due to public traffic obligations by municipalities or county councils. **Commercial bus traffic** refers to route-based traffic conducted by transport companies under their own auspices and entirely on commercial terms. Commercial traffic is usually carried out between large cities with few stops or for example to and from airports. Finally, **charter bus traffic** refers to such professional bus traffic that is not scheduled, it is usually carried out on request from companies and organizations. Charter traffic includes single tourist trips, events etc.

The observations for regional bus traffic were conducted during the day (7am −5pm) and evening (6 pm-9 pm). These observations were done at the last urban bus stop, before entering a rural area. Observations for commercial bus traffic and charter bus traffic took place in Stockholm, Gothenburg, and Malmö.

The focus group discussions included 7 groups: one with bus drivers (5 participants; 1 female), one with adult passengers (7 passengers; 4 females), one with parents to children 0–6 years old (4 participants; 3 females), two groups with children 7–12 years old (3 participants in each group; 4 girls), and two groups with children 13–17 years old (5 children in each group, 2 girls). The study was carried out in accordance with the 'Declaration of Helsinki' and informed consent were retrieved from all participants above 15 years old. For children the parents signed the informed consent. A structured interview guide was used, and the discussions were recorded and transcribed. The analysis was a thematic content analysis and transcriptions together with notes from the interviews were used to identify themes, but also to select and reproduce the quotes selected as central.

The web survey was conducted to provide a more comprehensive understanding of why passengers use or do not use the seat belt but also to verify if the results obtained via observations and focus groups were valid in a more general way. The link to the survey was distributed at the Swedish National Road and Transportation Research Institutes webpage (https://www.vti.se) and through Facebook, hence children < 13 years old were not included. In most questions the respondents were asked to answer per type of trip (regional bus traffic, commercial bus traffic, charter bus traffic). The survey included the following questions: How old are you? How often do you travel by bus? Did you use your seat belt on the last trip you took by bus? What is the main reason why you refrain from wearing a seat belt on the bus? If you use the belt, what is your main motive? On the last trip you took by bus, did the driver tell you to put on your seat belt? What do you think is the best measure to get passengers to wear seat belts when riding the bus? All questions had predefined answer options. The analysis was mainly exploratory and was performed in IBM SPSS Statistics v 29.

3. Results

The results from the *observation study* showed that passenger seat belt usage was 92% in charter bus traffic, 50% in commercial bus traffic and 27% in regional bus traffic. Comparing the results with the self-reported usage from the *web survey* show that passengers report a lower seat belt usage than in the observations (charter bus traffic 44%; commercial bus traffic 37% and regional bus traffic 31%). However, in the *web survey* they were asked to respond in relation to the last trip they made, irrespective of whether the bus was equipped with seatbelts or not. In regional bus traffic 25% reported travelling with a bus without seat belt, 8% in commercial bus traffic and 3 % in charter bus traffic.

In the *observational study* the bus drivers' use of seat belt was 100% in charter bus traffic, 79% in commercial bus traffic and 85% in regional bus traffic. The results from the *web survey* showed a lower level of usage for all three types of services, see Table 1.

The *focus group discussions* show that the reason for choosing to use a seat belt or not varies a great deal and factors like how old they were, long experience of bus travelling without incidents or accidents, what

Table 1
Observations - only buses with seat belts: Seat belt usage among passengers and drivers, Driver announcement of seat belt use. Web survey - last trip: Seat belt usage among passenger and announcement to use seat belt.

Seat belt usage, and announcement of seat belt use	Charter bus traffic (%)	Commercial bus traffic (%)	Regional bus traffic (%)
Observations – belt usage passengers	92	50	27
Observations – belt usage driver	100	79	85
Observations – announcement to use belt	86	61	19
Web survey – belt usage passenger	44	37	31
Web survey – announcement to use belt	34	21	9

Note: in the web survey buses without seat belt are also included.

kind of road they travel on, what time of the day they travel and how they perceived safety in general. The focus groups including children reported more frequent use of seat belts whereas belt usage was less common amongst youths and adults.

> Citation: "Yes, so that you (the child) don't sit and dangle, and if you crash or something, then it's good to wear, or it's good to wear the seat belt because, like it's good to have because, when you ride bus, it (the bus) usually dangles a bit like this. [10-year-old]".

In the citation above the participant makes some references to safety, however in the general the discussions the use of seat belts was not always linked to safety:

> Citation: " //… wearing a seat belt won't help anyway, it doesn't matter anyway, what are the chances we'll crash?" [10-year-old]

In the focus group discussion, there was a standard of belt use encouraged by bus drivers, parents, and other adults and using a seat belt was more established in charter bus traffic and in commercial bus traffic according to the participants.

Although this was encouraged it was not always complied with. This was something the youths meant could discourage children from using it as well.

> Citation: /…the only one I've seen wearing a seat belt on my bus, it's the kindergarteners, when they come with a whole class. Yes, then they have a belt. But they unbuckle their seat belts anyway.
> Yes, because they see that we don't have a belt. [17-year-olds]"

The focus group discussions also reflected on if there is relation between the willingness to use the seat belt and the duration of the trip. Although the observations showed that the usage rate at charter bus traffic was high, it should be noted from the focus group discussions that travellers themselves stated that they often removed the belt if they wanted to sleep or if it restricted them in any other way. Not all the participants agreed with this since some would argue that they were more motivated to use seat belt on long trips, and when travelling on roads with higher speed.

For shorter journeys, mainly on regional buses, passengers rarely used a seat belt. One reason for this might be that passengers worry that they will not have time to unbuckle it before leaving the bus.

> Citation: "It has happened that the belt also got stuck when I was going to get off once. Then I had to get off at the next stop [17-year-old]"

Other reasons for not using the seat belt on regional buses might be if the journey was in built up areas which the passenger perceived to be safer and therefore made them less motivated. The seat belt itself was stated by many to be a problem (dirty, technical problems to roll out, to lock etc.) and difficulties to wear it in general (too short, too long etc) contributed largely to it not being used.

> Citation: "Yes, it's so damn disgusting, at some point when I put the belt on, there was dirt on it. [17 year old]"

From the focus group discussions, we also learnt that passengers might benefit from a reminder.

> Citation: "I think significantly more people put on their seat belts if you get a reminder. It doesn't have to be that you ignore the belt. Maybe you're just distracted. You can be tired, or you are reaching for your wallet or phone or something, and then you kind of don't think about it. [Adult]".

Although bus drivers are legally responsible to inform and make sure passengers under 15 use the belt this can be difficult to ensure according to the bus drivers in the focus groups. Even if they make sure that all passengers are 'buckled up' at the start of the journey, it is still difficult to check that the seat belt is used during the whole journey. From their perspective some form of driver's support would be helpful, for instance, a red sign in the ceiling that is turned on if the belt is not attached, or seats that cannot be reclined unless the belt is used.

From an *enforcement point of view* the law about when to use seat belt in buses, but also the responsibility of the bus driver to check seat belt usage is therefore not clear to all. The general view is that the law does not matter if it is not enforced.

> Citation: "You have never heard that it has happened that someone has been fined, which also means that you don't stick to it. [17 year old]"

In regional bus traffic a different type of buses are used. The logic behind having to use a belt on a regional bus travelling in a low-speed urban environment is not easy to understand, especially if the person on the next trip on a high-speed road have to stand in a bus with no belts:

> Citation:"The bus here has a seat belt, the bus home depends on which one I take, so say every other bus has a seat belt home, every other does not…// [17 year old]

The results from the *web survey* showed that the main reason passengers refrained from wearing a seat belt on the bus was that no one else was doing it (10 % in charter bus traffic – 18% for regional bus traffic) and that it was not very comfortable (approx. 18% in charter, commercial and regional bus traffic). The main motivation to 'buckle up' was safety (approx. 55 % in charter, commercial and regional buses).

The web survey also showed that the passengers rated the best measure to get passengers to wear seat belts as "technical solutions" (about 20%) and "support for the driver" (about 20%) but also an increased social pressure (about 10%) and making sure there is more space so that they don't have to sit close to other passengers (about 12%). There was no major difference in the results for charter, commercial and regional buses.

4. Discussion

The results from the observations showed that seat belt usage differed depending on the type of operation. Seat belt usage was most common in charter bus traffic (92%) and less common in regional bus traffic (27%). For commercial traffic, the observed usage rate was 50%. The reason for using the seat belt more often in charter and commercial bus traffic might be that the buses used for this type of service were more often of a better standard with more comfortable seats and better belts. It might also be because charter and commercial bus operation drive on roads with higher speeds, such as motorways, and then the passengers find it more justified to use the seat belt. However, it is difficult to determine exactly why there are such large differences between types of operation and probably it is dependent on all the reasons mentioned above.

More frequent and clearer communication from the bus drivers

regarding the need to use seat belts might be useful. Indeed, higher seat belt usage among drivers and announcements to 'buckle up' were associated with higher seat belt use among bus passengers. This is in line with earlier studies that show positive effects for children's seat belt usage if the driver announces that they need to put them on (Mehta and Lou, 2013). It is not known if this has an effect also on adults. However, the focus group discussions highlighted that it would help if they were reminded so there is reason to believe it might have a positive effect.

There is also reason to believe that older children stop using seat belts as they gain more experience of safe bus riding and thus become increasingly convinced that they are safe on board. In a sense, they are right as the statistics that are available clearly show that it is generally safe to travel by bus (Albertsson et al., 2006). However, Wretstrand et al. (2014) analysed hospital reported injuries for urban bus travelling showing that the majority of injuries during bus travelling are when passenger fall while standing or moving on board (66%), and especially during hard accelerations and braking (85%). Although, for such urban travelling at low speed (<60 km/h) it might be more effective to make sure there are seats available for all passenger than to provide seat belts on all seats.

According to the focus group discussions, it was less common to use a seat belt on short journeys, which were likely to take place in urban areas with lower speeds. Similar results have been presented, indicating that this would apply to both bus passengers and car passengers (Dissanayake and Parikh, 2012; Jermakian and Weast, 2018; Kidd et al., 2014). According to the participants in the focus group a journey in a built-up area was perceived as safe, which in turn made them less motivated to use the belt. This also agrees with other studies which have found that the perception of safety (Jermakian and Weast, 2018) and perception of severity if involved in a crash (Nambulee et al., 2019) are closely linked to seat belt usage. Another reason for not using the seat belt on regional buses could be that those buses are not always equipped with seat belts, and it is not unusual during rush hours that passengers must stand up. This in turn would prevent passengers from forming a habit but also prevent them from understanding why they shall use a belt.

The design and usability of the seat belt were other factors which had an impact on usage. In the focus groups, participants reported that they did not use the seat belt on long trips to get more comfortable. If the belt is comfortable or not is an important factor which determines usage (Jermakian and Weast, 2018; Kidd et al., 2014; Shaaban, 2019; Şimşekoğlu and Lajunen, 2008) but not only on longer trips (Kidd et al., 2014). To make seat belts more comfortable appears to be important and different solutions have been suggested such as seat belt cushions (Shaaban, 2019). Which factors are most important to promote belt use is difficult to determine, but a nonlinear function has been developed showing that in school buses the driver's actions are of great importance, greater than, for example, information via stickers (Lou et al., 2011). The authors of the study propose an extended driver training dealing with the benefits of seat belts as the most cost-effective measure.

The results found that passengers were less likely to use the belt on long journeys if they wanted to sleep. Studies show that crashes with serious injuries and fatalities are more common at night (Feng et al., 2016) which to some extent probably has to do with seat belts not being used to the same extent as during daytime. There is also in general an increased risk of a crash due to driver fatigue at night time (Bioulac et al., 2017), that also put an extra risk on passengers during night time travelling More focus on understanding the positive effect in case of a crash might be an effective countermeasure. This is most likely an effective solution for buses on high-speed road (>60 km/h) since most severe injuries and fatalities are during rollover. In such crashes, the seat belt is very effective to save life, especially 3 point belts (Albertsson et al., 2006).

The driver has a legal responsibility to inform and make sure passengers under 15 use the belt. However, the results from the focus group discussions with drivers revealed that it was not always possible for them to be aware of passengers not using seatbelt while they were driving. In this case, some technical solutions, such as seat belt reminders, might be useful, similar to the seat belt reminders used in passenger cars (Dahlstedt, 2001).

In this study drivers own use of the belt was also assessed. The results from the observations showed that bus drivers do not always use the seat belt and in order to increase their usage a technical solution preventing them from driving in higher speed if not belted might increase usage (Van Houten et al., 2010). According to Kidd et al. (2014) drivers were also more likely to buckle up in response to an auditory and haptic reminder than a visual reminder. Since 2021, it is obligatory to fit all front and rear seats of M1 vehicles, as well as all front seats of M2 and M3 vehicles, with seat belt reminder systems for all new vehicles (UN regulation no. 16).

The results from the focus group discussions show that the standard (size, hygiene, technical functionality etc) of belts have an impact on usage. Studies are underway internationally to develop guidelines for how belts in buses should best be designed with a starting point in the UN regulation No.14 (ECE RV14). The aim is to find a method for type approval (Hernan and Fernando, 2018). Hopefully this will also improve the technical functionality.

On short trips there was a worry of not being able to unbuckle in time to get off. Another concern, according to the participants in the focus groups, was that trying to reach the belt to 'buckle up' could result in an unwanted interaction with the passenger next to them. Especially children expressed that this could be very difficult and a barrier for belt usage. The web survey also supports this since more space to other passengers were one of the most rated mitigations.

This study suffers from certain limitations. One is that the observations of passengers in real traffic was difficult to perform and that an observer counting belted and not belted passengers could have resulted in an increase in seat belt usage. Another limitation is the risk of missing situations when passengers un-buckle during long trips, especially in the middle of the night. However, thanks to the combination of observations, focus groups and web survey we were able to get a wider understanding of seat belt use and the reasons for not using them. There is no absolute measure of belt usage, but at least a deeper understanding has been achieved. A limitation is also that in the web survey we had to ask about the last trip they made. Hence, this trip could have been with a bus without seat belts. This makes it important to be careful when comparing the results with the observation study, in which only buses with seat belts installed were included. In addition the respondents on the survey is a bit limited, since the links to the survey were distributed on through web and Facebook. There is no possibility to estimate if this represents all possible bus passengers' view. The focus groups were performed in two southern cities in Sweden (Linköping and Gothenburg). Even though we collected a great deal of information it is difficult to say if the results can be generalized to people living in the north of Sweden. This is a clear limitation.

It can be concluded that seat belts are not always used, especially in regional and commercial bus traffic. Mitigation strategies are needed, especially for travelling on rural roads with higher speed.

5. Conclusion and recommendations

The seat belt use among bus passengers can be improved especially in regional and commercial bus traffic. It is more common to buckle up on long trips than on short trips. However, even though observations show high usage during long trips, travellers report that they remove the seat belt after a while if they want to sleep or for comfort reasons. For the bus drivers it is not possible to control passengers' usage. Dirty seat belts and technical malfunction might deter some passengers from using them and therefore systematic cleaning and control of seats and belts are recommended. On short trips one reason for not using the belt is related to worries about getting stuck and not being ready to get off in time. In general, it is most important to increase the usage on high-speed roads

(>60 km/h), in lower speed it might be more important to provide a seat for each passenger.

Based on the results the following recommendations are given:

- Information about seatbelt requirements. Partly through mandatory announcements about the use of seat belts by the driver in the bus, but also information through other media that seat belts are required and perhaps more importantly why they should be used.
- Ideally, the announcements could be replaced by seat belt reminders as used in passenger cars.
- Support for drivers, partly to increase their own seat belt use, but also technical support to be able to get information about seat belt use on the bus they drive. Likewise, routines and timetables that give the driver the opportunity to wait for departure so that passengers have time to put on/off their seat belts are desirable.
- Clearer enforcement by extending ticket control to also apply to control of seat belt use. If the bus has a ticket controller this person should also check seat belt usage and be entitled to fine those who do not use belt.
- Requirement for seat belts to have a length and design so that both large and small passengers can use them.
- Regulatory changes so that seat belt requirements comply with belt usage requirements and that they are adjusted to ensure consistent use of force are recommended. At speeds over 60 km/h seat belt usage should be mandatory, and all passengers should be offered a seat with a belt. At speeds of 60 km/h or less, belt requirements should be investigated further. At lower speed the measures with the greatest safety benefit are to ensure that all passengers are seated, rather than being belted.
- Systematic cleaning and control of seats and belts is recommended.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Some data will be possibele to share on request, but not all.

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