Institute of Transport Economics
Norwegian Centre for Transport Research

ENGLISH Summary

Safety in bus transport in Europe

Status of safety and discussion of measures benefitting drivers, passengers and other road users

TØI Report 1984/2023 • Authors: Tor-Olav Nævestad, Alena Katharina Høye, Rune Elvik • Oslo 2023 • 64 pages

This report provides an overview on the current status of road safety in bus transport and potential measures for improving traffic safety in bus transport; for drivers, passengers and road users outside the bus. The report aims to provide decision-makers and procurers with a basis for setting effective and relevant requirements for enhanced traffic safety. We recommend that the following measures are made mandatory in bus transport: 1) Fleet management systems to facilitate a soft driving style, 2) Safety culture measures, 3) Safety management systems, 4) Crash protection for bus drivers. These measures are not legally required in bus transport, although they are highly effective for preventing accidents. Safety culture measures and Safety management systems are required in other transport sectors, with a high safety level (e.g., aviation, rail, maritime sector). Other measures are already required, but not fully implemented in practice. Given their efficiency, a relevant step would be to find measures aiming to increase their implementation. This applies e.g., to measures to increase seat belt use among passengers in class 3 and 2 buses. Additionally, there are also several measures which seem promising, but for which there is little relevant research, or the current versions of the technology might not seem fully developed yet, indicating a need for further research. This applies e.g., to geofence speed limiter, warning systems for vulnerable road users and emergency braking, run over guards and pedestrian airbags, measures to prevent fall accidents on-board buses, measures to secure wheelchairs and baby buggies.

Background

Travel by public transport – bus, train or tram – is very safe and perceived to be so. In recent years, several bus drivers have, however, been involved in serious accidents on Norwegian roads, under conditions which should not indicate serious outcomes. Recent reports indicate that large numbers of passengers are injured in incidents onboard buses. Additionally, there is a societal shift to both increased bus transport in cities as well as an increase in vulnerable transport modes, e.g. walking, cycling, e-scooters etc. which might lead to an increase in conflicts between buses and vulnerable road users in cities

Aims

The study seeks to develop an overview on the status and potential measures for improving driver and traffic safety in buses. The report will provide decision-makers and procurers with a foundation for setting effective and relevant requirements for enhanced traffic safety. The aims of the study are to provide:

1) An overview of the traffic safety situation and historical accident statistics for bus transport in Norway and Europe.
2) Description of the necessary safety management systems and safety culture features required to improve traffic safety in bus transport.
3) Overview of measures to reduce the occurrence of accidents, including estimated effectiveness of these measures where possible.
4) Overview of potential measures to reduce the consequences of accidents, including estimated effectiveness of these measures where possible.
5) Rating of the measures, based on whether they lead to reductions in accidents, uncertainty, and relevance.

Methods

We have used three methods in the study: 1) Data on road accidents, incidents, and exposure to calculate the frequency and risk of accidents and incidents in bus transport, 2) Interviews and informal discussions with key stakeholders to map the state of the art of bus safety measures, 3) Literature review to summarize available knowledge about the safety effects of measures to improve safety in bus transport. The measures are divided into the following categories: organisational measures, measures addressing onboard passenger safety, crashworthiness and driver protection, crash protection for vulnerable road users, driver assistance systems – mandatory systems, driver assistance systems – optional systems and other measures. Thirty-tree specific measures are reviewed.

In the review of each measure identified in the literature review, we address the following questions: 1) Has the measure been studied in buses? 2) Does the measure reduce accidents or injuries? 3) Who benefits from the reduction in accidents or injuries? 4) How uncertain is the effect? 5) Does the measure conflict with other objectives? 6) Is the measure relevant to the traffic safety situation? We rank the measures based on effectiveness, using an evaluation where we assign points for each of the mentioned questions. Based on these calculations, we calculate a total score for each measure. The knowledge about each measure is summarized in six points in the form of a table in the following format (*Table* 2.1).

Table S.1: Qualitative and quantitative criteria for assessment of measures in the literature review.

	Measure studied on buses?	Does the measure reduce accidents / injuries?	Target group of road users	How uncertain is the effect?	Is the measure in conflict with other measures?	Is the measure relevant?
Qualitative assessment	Yes / No	Yes, a reduction of A-B percent / No	Persons within bus / Other road users	High / Medium / Low	Yes, in which case which measures / No	Yes / No / Maybe
Quantitative assessment	0: No / 1: No, but in other relevant cases / 2: Yes	0: No / 1: Yes, most likely / 2: Yes, small effect / 3: Yes, large effect	Driver / Vulnerable road users / Other road users / Passengers / All	1: High / 2: Medium / 3: Low	-1: Yes / 0: No / +1: No, and other benefits (e.g. reduced omissions)	0: No / 1: Yes, maybe / 2: Yes, to some extent / 3: Yes, to a large extent

Results

Traffic safety situation. The first aim is to provide an overview of the traffic safety situation and historical accident statistics for bus transport in Norway and Europe. European data indicates that between the years 2010 and 2019, the number of fatalities in crashes involving buses/coaches has decreased by 34%. There is a high proportion of vulnerable road users (37%), especially pedestrians (29%) in bus accidents, probably because of the urban environment in which many buses operate. Norwegian data shows that the risk of injury to bus drivers in road accidents has declined over time. The same applies to bus passengers. Bus drivers have about the same risk of injury as car drivers, but a higher risk of injury than bus passengers. Moreover, bus passenger injuries are very incompletely reported. Most injuries to passengers do not result from traffic accidents, but from events onboard and when going on/off bus. These events represent 80-85 % of all injuries to bus passengers. We analyse such incidents based on reports to Norway's largest transit authority, Ruter.

Organisational management measures. The second aim of the study is to provide a description of the necessary safety management systems and safety culture features required to improve traffic safety in bus transport. Safety management systems consist of formal procedures and measures that enable organizations to work systematically with safety, such as identifying risks through formal risk analyses, developing and implementing corrective measures (e.g., procedures, training), defining roles and responsibilities, regularly monitoring status, tracking various safety indicators (KPIs), and implementing corrective measures if necessary (Thomas, 2012). Safety management systems denote the formal aspects of safety management in organisations. The informal aspects of safety, or "what people actually do," are related to safety culture. Safety culture refer to shared and safety relevant ways of thinking and acting (Nævestad 2010). It is mostly measured as management (and employee) commitment to safety and perceptions of whether aspects of safety management systems are "alive" and relevant. For safety management systems to be effective, they must be combined with, or used as a tool to create a good safety culture (Nævestad et al., 2018b).

There is generally less focus on safety culture and safety management in the road sector compared to other transport sectors. This is explained by the fact that road sector companies do not have the same legal requirements for safety management systems as in aviation, maritime sector, and railways. Despite legal requirements, several bus companies work systematically with safety management systems and safety culture, and our research indicates that this is related to positive safety outcomes. The same applies to another organisational safety management measure; working systematically with fleet management systems to ensure a soft driving style. This measure is related to positive safety outcomes, and it is relevant for several different types of injuries in bus transport, both applying to traffic accidents and non-collision passenger incidents onboard the bus. An important aim of the study is to rate the measures, based on whether they lead to reductions in accidents, uncertainty, and relevance. The organisational management measures are among the bus safety measures with the highest overall rating: Fleet management system is rated as number one, safety culture measures as number three and safety management system as number seven.

Measures to reduce the occurrence of accidents. The third aim is to provide an overview of measures to reduce the occurrence of accidents, including estimated effectiveness of these measures where possible. The five most effective and relevant measures studied (ranked according to their score), in addition to the three mentioned organisational measures are: blind spot warning and measures for improved visibility.

Measures to reduce the consequences of accidents. The fourth aim is to provide an overview of potential measures to reduce the consequences of accidents, including estimated

effectiveness of these measures where possible. The five most effective and relevant measures studied are, ranked according to their score: seat belt in class 3 buses, measures to increase seat belt use for bus drivers, seat belt in class 2 buses, crash protection for bus drivers and seat belt in class 1 buses.

Limitations

It should be mentioned that our rating and assessment of masures, based on whether they lead to reductions in accidents, uncertainty, and relevance (i.e. fifth aim), is conservative and biased in the sense that we tend to rate existing and "older" measures higher. The reason is that there is more research on older measures, and thus more information on effects on accidents, less uncertainty, more well developed and user friendly technology etc. We attempt to compensate for this bias by also highlighting measures which seem promising, but for which there is little relevant research, indicating need for future research.

Recommendations

Many of the measures that we rate are already legally required in bus transport and are thus implemented in companies. We rate them nevertheless, to provide an overview of efficiency and relevance. Several measures that are legally required get high ratings in our assessments. It is, however, of more relevance to provide recommendations based on efficient and relevant measures that are not legally required (yet), and which thus are not fully implemented. When it comes to such measures, some companies might have them, but not all, as the measures are not mandatory. Based on that, we recommend that the following measures are made mandatory in bus transport: 1) Fleet management systems to facilitate a soft driving style, 2) Safety culture measures, 3) Safety management systems, 4) Crash protection for bus drivers. These measures are not legally required in bus transport, although they are highly effective for preventing accidents. Safety culture measures and Safety management systems are required in other transport sectors, with a high safety level (e.g. aviation, rail, maritime sector). Measure 1-3 should be required by public transport authorities through contracts with bus operators. When it comes to measure 4, we recommend a separate European standard for collision safety in buses (instead of the current situation, which involves that buses are covered by regulations for other types of vehicles).

Other measures are already required, but not fully implemented in practice. Given their efficiency, a relevant step would be to find measures aiming to increase their implementation. This applies e.g. to measures to increase seat belt use among passengers in class 3 and 2 buses. This could be done by both national authorities and public transport authorities.

Additionally, there are also several measures which seem promising, but for which there is little relevant research, or the current versions of the technology might not seem fully developed yet. This indicates a need for further research. This applies e.g. to geofence speed limiter, run over guards, warning systems for vulnerable road users and emergency braking, pedestrian airbags, measures to prevent fall accidents on-board buses, measures to secure wheelchairs and baby buggies. These measures need to be further developed and examined by a range of key stakeholders in bus transport.