International Co-operation on Theories and
Concepts in Traffic Safety

Conceptual model for assessing mode shift impacts on road fatalities and injuries

[1*]Maasalo, I., [1]Lehtonen, E., [1]Malin, F., [1]Fadel da Costa, A. & [1]Innamaa, S.
[*]lead presenter ida.maasalo@vtt.fi
[1] VTT Technical Research Centre of Finland, Finland

Introduction

The accumulation and severity of traffic accidents are influenced by three dimensions: exposure to accidents, risk, and consequence (Nilsson, 2004). It is expected that automated vehicles (AVs) of high technological readiness would have a lower risk of accidents compared to manually driven vehicles (MVs). However, assessing the influence of AVs on changes in exposure and mode shifts is not straightforward, and various AV concepts that will exist in the future may have different effects on mode shifts. For example, if AVs provide travel options for the first or last miles to public transport, they could shift traffic from passenger cars to public transport, and thus further increase safety. Conversely, if only private AVs (automated passenger cars) are available and there is no enhancement in the quality of public transport, travelling by car may increase and shift users away from public transport, which currently presents a very low accident risk for its passengers. Consequently, despite of lower accident risk per kilometre driven than for MVs, private Avs might even increase the overall accumulation of road fatalities and injuries due to increased exposure.

The aim of this study is to develop a conceptual model that illustrates the impacts of mode shifts on road fatalities and injuries within the entire transport system when private AVs enter the transport system. The model considers nine impact mechanisms (IMs) (Kulmala, 2010) that describe both direct and indirect changes associated with AVs across the three dimensions of safety (Innamaa et al., 2018). The model can be used as a basis for future analysis that also utilizes quantitative data.

Methodology

First, the model describes factors that, based on a literature review, are connected to exposure, risk and accident severity. Second, the model describes which safety-related factors are associated with each of the IMs for AVs. Finally, the impact of the mode shifts on road fatalities and injuries is illustrated.

Results

The conceptual model is presented in Figure 1. The top part (A) illustrates the factors influencing to the accumulation of fatalities and injuries for a specific mode. It indicates that trip attributes (e.g., travel time, distance, cost, and purpose), and road user characteristics (e.g., sociodemographic and -economic backgrounds, habits, and attitudes) influence choices of mode and route. Environmental factors (e.g., road type, road network configuration, weather, and lighting) are also connected to mode choice and might especially influence the choice of AVs, as their automated driving systems have an operational design domain that restricts their use to specific environments or conditions. The illustration shows that mode choice and the penetration rate of AVs affect exposure. The model also describes that road user characteristics and environmental factors influence traffic behaviour, which then influences risk and accident severity. The illustration also details which factor is associated with each IM. For example, IM1 (Direct modification of the driving task, driver behaviour, or travel experience) is related to traffic behaviour, while IM7 (Modification of modal choice) and IM8 (Modification of route choice) are related to mode and route choice.

The bottom part (B) illustrates how the mode shifts affect the accumulation of exposure within that mode (red circle), and subsequently the accumulation of road fatalities and injuries. The model describes, as

it is, the contributions of MVs, private AVs, public transport, and active travel (e.g., cycling and walking) to road fatalities and injuries. However, it would be possible to consider the influence of any kind of modes, or various AV concepts, if needed.

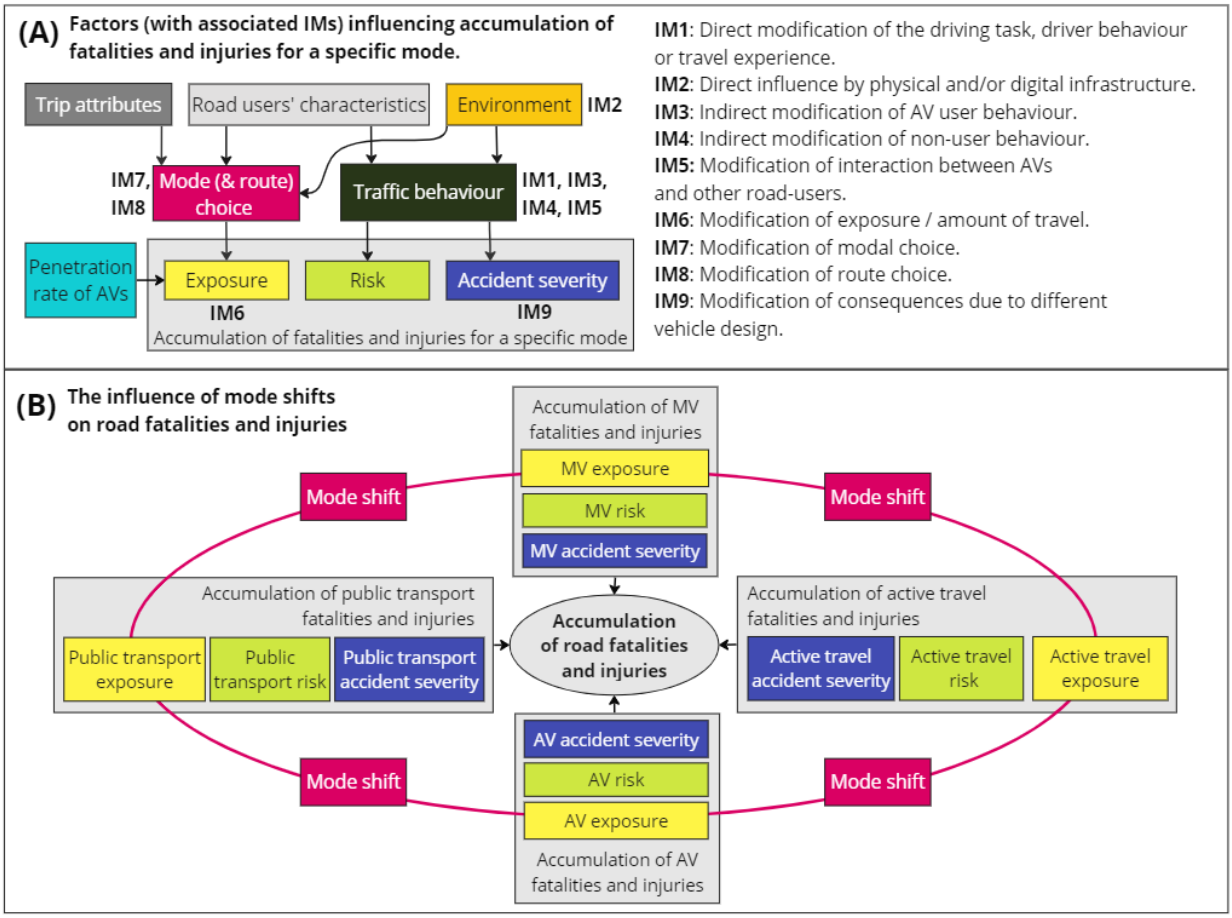

Figure 1. Factors (with associated IMs) influencing accumulation of fatalities and injuries for a specific mode (A) and the influence of mode shifts on road fatalities and injuries (B).

Discussion and conclusions

The conceptual model shows what factors need to be considered when assessing how AVs will contribute to the accumulation of accidents for a specific mode and overall within the transport system. The conceptual model can be used as a basis for a quantitative model, which can then be used to assess the safety impacts of AVs. This will be done for private AVs in the Hi-Drive project, and the presentation will be complemented with results as they become available.

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