Necessity and Proposed Procedure for a Classification of Security Features in Shared Automated Vehicles Based on the Kano Model

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ABSTRACT

Shared automated vehicles (SAVs) will contribute to tackling several of today's mobility problems. In rural areas, they will help to improve transport links to underserved regions and in congested urban environments, they have the potential to free up valuable road space by bundling individual journeys. However, their beneficial effect is strongly dependant on high acceptance rates. In conventional shared mobility concepts, non-verbal, verbal or physical assaults on passengers by fellow travellers are a major obstacle to acceptance and negatively influence usage rates. There is reason to assume that harassment and other anti-social behaviour will also take place in SAVs and prior studies were able to identify in-vehicle security as a major passenger concern. In order to achieve high acceptance rates and benefit from the advantages SAVs can bring, it is indispensable to provide users with vehicle interiors that ensure a secure and fearless journey. Currently, little is known about user preferences regarding possible security features and there are no interior concepts that prioritize in-vehicle security. Furthermore, there is so far no classification of security features that could serve as a guideline for vehicle manufacturers. This paper suggests the use of the Kano-Model as a way to efficiently assess and categorise different in-vehicle security features and proposes a dual method approach to experimental validation.

Keywords: Automated Driving, Shared Automated Vehicles, Shared Mobility, Security, Kano Model.

1. INTRODUCTION

Urban environments suffering from congestion and rural areas where there is little or no public transportation due to lack of staff or demand are two types of mobility related issues that need to be addressed in order to make transportation more sustainable. In the context of mobility on demand, these problems could at least partially be solved in the near future with the help of automated ride pooling (ARP). Hyland et al. (2020) state that sharing rides offers a range of societal as well as personal benefits compared to the individual use of automated vehicles and that a larger demand for shared rides might trigger an upward spiral by leading to lower service fees and therefore even more demand. However, the assumptions of this best-case scenario are based on users' acceptance of sharing rides with strangers in a relatively small space compared to what they are used to in

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conventional public transportation. There, frequent cases of harassment and assaults represent a usage barrier. While exact numbers strongly depend on survey type and sample, findings like the one from Weinstein Agrawal et al. (2020), where two in three respondents reported having experienced some form of harassment, are no exception. Furthermore, the authors report that 25 % of public transport users – in this case American college students – reduce their journeys out of fear, with women being far more affected than men are. Similar findings are reported by Colliard et al. (2018) for France and Gerhold (2020) for Germany. While the anonymity within public transportation systems certainly influences the incidence of assaults, even mobility systems that require strong verification from both, driving personnel as well as users such as ride hailing are not free from crime (Lyft 2024, Uber 2024). Though there is yet no real-world data regarding the state of security in SAVs, there is reason to believe that their success strongly relies on how secure passengers objectively are but also subjectively feel.

2. POTENTIAL CLASSIFICATION OF SECURITY FEATURES

There is currently hardly any data on the acceptance or effectiveness of security features in SAV interiors. As a result, it is also unlikely that vehicle manufacturers, potential service providers or local authorities interested in implementing ARP will have a security concept ready that meets user needs. A classification of potential security features would allow for a subsequent evaluation with regard to a cost-benefit assessment, offering stakeholders clear and simple recommendations in this regard.

Three factors likely determine the applicability of SAV security features. Firstly, the cost to a vehicle manufacturer of implementing the feature in series production. Secondly, the effectiveness in terms of a given feature's ability to ensure security on board. Thirdly, the extent to which users accept an individual feature. At present, automated driving technology is not yet ready for large-scale deployment. In addition, manufacturers still seem to lack a concrete idea of how future ARP vehicles can accommodate user needs (Dorynek et al. 2022). It is therefore extremely difficult to estimate the concrete costs that a specific security feature would cause. Furthermore, due to the lack of regular ARP operation, it is not adequately possible to test the effectiveness of individual features empirically, resulting in user acceptance being the only one of the three factors that can be researched sufficiently at the time. In this regard, the Kano model (Kano et al. 1984) is a proven method for classifying individual product features with the aim of increasing customer satisfaction and it consists of five categories into which a product quality can fall. Specifically, these are must-be, one-dimensional, attractive, indifferent, and reverse qualities. The application of the Kano model promises a quick and easy categorisation of individual features and has been recently applied in the fields of automated driving (Shin et al. 2022) and user experience (Kölln et al. 2023). With its help, a valuable initial overview can be gained of which security improvements must be present in any case, which have a particularly large effect on user acceptance as attractive qualities and which should ideally be avoided. With regard to the question of data collection, two options stand out in particular. Firstly, the basic feature classification could be carried out by means of a large-scale quantitative online survey. The data collected in the first step should then be validated by a subsequent qualitative experiment that uses a more realistic test environment to verify the results of the first study. Due to the implementation

of security features as part of a physical prototype being costly and time-consuming, a virtual reality setting seems suitable for this purpose.

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