Disuse of advanced driver assistance systems (ADAS)

Kim, Soyeon; Oviedo-Trespalacios, Oscar

DOI
10.1016/j.jsr.2025.09.004

Publication date
2025

Document Version
Final published version

Published in
Journal of Safety Research

Citation (APA)
Kim, S., & Oviedo-Trespalacios, O. (2025). Disuse of advanced driver assistance systems (ADAS). *Journal of Safety Research*, *95*, 180-188. https://doi.org/10.1016/j.jsr.2025.09.004

Journal of Safety Research 95 (2025) 180–188

Contents lists available at ScienceDirect

Journal of Safety Research

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

Disuse of advanced driver assistance systems (ADAS)

Soyeon Kim [a,*], Oscar Oviedo-Trespalacios [b]

[a] Department of Transport and Planning, Faculty of Civil Engineering and Geosciences, Delft University of Technology, the Netherlands
[b] Department of Values, Technology and Innovation, Faculty of Technology, Policy & Management, Delft University of Technology, the Netherlands

ARTICLE INFO

Keywords:
Automated vehicles
ADAS
Disuse
Human-Machine Interaction
driver behavior

ABSTRACT

Introduction: The advancement of advanced driver assistance systems (ADAS) aims to enhance driving safety, efficiency, and convenience. However, their potential remains underutilized as drivers frequently disengage or avoid using these systems. This study investigates the phenomenon of ADAS disuse, encompassing situational disengagement and systematic avoidance, through in-depth interviews with SAE Level 2 automated vehicle drivers. *Method:* Using thematic analysis, we identified nine key themes influencing disuse across three domains: Driving task (strategic, tactical, and operational level of driving tasks); Human (sense of control, knowledge, trust, and responsibility); and Environment (road users and road situation). *Results:* Drivers cited discomfort with system aggressiveness, lack of trust in detection capabilities, and incompatibility with their driving styles as critical factors. Environmental complexities, such as construction zones and pedestrian-heavy areas, further exacerbated disengagement. Additionally, legal and moral responsibility emerged as influences on drivers' preferences for manual control. *Conclusions:* Our findings underscore the need for adaptive, user-centered designs prioritizing trust, transparency, and context-sensitive system behaviors. By addressing these barriers, ADAS can achieve safer and more consistent adoption, supporting broader goals of accident prevention and traffic efficiency. *Practical Applications:* This study provides insights for enhancing ADAS design and fostering driver confidence, paving the way for their effective integration into modern mobility solutions.

1. Introduction

The development of advanced driver assistance systems (ADAS) is motivated by the pressing need to improve driving safety while exploring new opportunities to enhance convenience and increase efficiency. For example, Tesla's Full Self-Driving (FSD) Beta is a partial driving automation feature that expands the operational design domain of Autopilot beyond highways to non-highway roads. Drivers still need to monitor and keep their hands on the steering wheel, but the vehicle drives itself to its destination. However, despite the potential benefits, it has been observed that drivers avoid engaging with these systems. For example, Nordhoff (2024) shows that drivers using FSD Beta disengaged the feature due to several reasons, such as drivers' perception of driving automation or other road users. He et al. (2022) demonstrates that drivers in partial driving automation override control when their perceived risk is high, such as short-distance cut-in. Nandavar et al. (2023) found that drivers perceive certain driving automation features as better suited to their needs than others, resulting in some technologies being underutilized, which can impact their adoption. While ADAS are designed to reduce risks by mitigating variability in driving performance, their widespread success relies on drivers consistently using them as intended. Given that ADAS are developed to assist driver safety, this situation warrants deeper investigation due to its implications for safety, system efficacy, and the future development of automated vehicles.

The terms 'disengagement' and 'disuse' are often used interchangeably in the context of automated driving. 'Disengagement' refers to the temporary, situational deactivation or avoidance of ADAS, often triggered by immediate contextual factors such as weather conditions or the need to navigate complex environments (Nordhoff, 2024). In contrast, 'disuse' implies a more prolonged, systematic choice by the driver to avoid the capability of automation (Parasuraman & Riley, 1997). While disengagement may appear as isolated incidents, it could contribute cumulatively to an overarching pattern of disuse, influenced by underlying concerns or dissatisfaction with ADAS. In this study, we will use the term 'disuse' to encompass both situational disengagement and more consistent avoidance, as disengagement events may accumulate over time, leading to complete disuse if unresolved. Early conceptualizations

* Corresponding author.
E-mail address: s.kim-4@tudelft.nl (S. Kim).

https://doi.org/10.1016/j.jsr.2025.09.004
Received 10 March 2025; Received in revised form 1 July 2025; Accepted 8 September 2025
Available online 4 October 2025

have grouped these terms under the broader category of 'non-use when beneficial,' representing a form of technology misuse (Oviedo-Trespalacios, 2024). However, research in this area has thus far remained strictly theoretical, lacking empirical evidence to explore this behavior and its dimensions, which is essential for a comprehensive understanding of these complex phenomena.

The reasons for disusing ADAS vary widely, encompassing factors such as trust, perceived risk, driving styles, and ease of use. Trust is frequently associated with the operator's willingness to engage with automated systems (Chiou & Lee, 2023; Hancock et al., 2011; Kelly et al., 2023; Lewis et al., 2018; Merritt et al., 2013). It is a multifaceted concept determining an individual's willingness to delegate tasks to an automated system and rely on its outputs. According to Hoff and Bashir (2015), trust consists of dispositional, situational, and learned components. Recent studies have indicated that various factors, such as system performance (Kenesei et al., 2022), perceived reliability (Azevedo-Sa et al., 2021) and perceived safety (Nordhoff et al., 2021), transparency of processes (Kraus et al., 2020), and prior experience with automated systems (Molnar et al., 2018), contribute to the formation of trust in automated vehicles. Responsibility also shapes how humans interact with automated systems. Unlike trust, which primarily concerns the user's perception of the system's capabilities (Lee & See, 2004), responsibility is more closely related to their perception of their role in the task (Barki & Hartwick, 1994). When humans perceive that they will be held accountable for outcomes, they may be less likely to trust an automated system. On the other hand, even when trust in a system is maintained, responsibility can lead to the decision to discontinue its use. This paradox occurs when humans trust the system's capabilities but choose to disengage due to their high responsibility for the outcomes. In addition, differences in driving styles between the driver and the automated system can also prompt disuse. Delmas et al. (2023) showed that drivers generally prefer lower speeds than their own, but drivers with sufficient trust in automated vehicles preferred an automated vehicle speed almost identical to theirs. An automated vehicle's driving styles not aligning with drivers' driving styles reduces trust and increases the frequency of takeover of control (Ma & Zhang, 2021). Another reason for disusing ADAS is the lack of transparency about how these systems work, their capabilities, and limitations (Endsley, 2023; Kraus et al., 2020). Usability and intuitive design also affect the adoption of automated vehicles. Drivers may find the information presented by ADAS to be either non-intuitive or overwhelming, which can hinder engagement and confidence in these systems (Carsten & Martens, 2019). Poorly designed user interfaces or confusing alerts may lead to user dissatisfaction, subsequently reducing reliance on ADAS. In addition, contextual driving factors also influence the use of ADAS. Drivers perceive ADAS as a useful tool primarily in low-stress situations, such as long commutes, but may avoid it when they feel capable of independently managing the driving environment (Nordhoff et al., 2023). For example, in adverse weather or heavy traffic, drivers may refrain from engaging in driving automatic due to concerns about sensor limitations and system decision-making in complex scenarios (Gershon et al., 2023). While the trust in automation issue is major, recent studies underscore that drivers' decisions around ADAS disuse arise from a combination of personal preferences, perceptions of the system, and situational factors.

When considering the disuse of ADAS, it is necessary to look beyond just the decision to adopt the technology and examine it from a safety perspective. ADAS generally detect potential hazards and initiate corrective actions more effectively than human drivers, so disengagement from these systems can reduce the vehicle's capacity to respond efficiently to threats (Hancock et al., 2019). For example, adaptive cruise control (ACC) is designed to detect safe distances and respond to traffic changes, potentially reducing accident risk. When drivers choose not to engage these features, the vehicle's ability to handle such risks may be compromised. From a traffic flow management perspective, the disuse of ADAS also disrupts vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. These real-time data-sharing forms enable collaborative safety features that rely on real-time traffic adjustment. For example, ACC works cooperatively with other automated systems to adjust vehicle speed, maintaining smoother traffic patterns; however, this benefit is lost when the system is deactivated (Jiménez et al., 2016). By disengaging from ADAS, drivers may unintentionally diminish the effectiveness of these cooperative safety mechanisms, impacting not only their vehicle but also the broader traffic network.

This study explores the underlying reasons behind the disuse of ADAS. While some barriers to automation adoption may be addressed through future technological advancements, more fundamental issues, such as trust, interaction dynamics between humans and systems, comfort levels, or psychological resistance stemming from personal preferences, are less likely to be resolved purely through technical improvements. Given the interdependent relationship between ADAS design and user experience, understanding why drivers hesitate to engage with these systems can reveal valuable insights for improving interaction design and support structures for future automation. By providing a comprehensive perspective on the use of ADAS from SAE Level 2 automated vehicle drivers, this study contributes to a nuanced framework for automated vehicle design, aiming to support safer and more consistent adoption through improvements in drivers' experience and safety.

2. Method

In this research, we use data from in-depth interviews to investigate drivers' usage of advanced driver assistance systems (ADAS), as this method provides a robust approach to understanding the complex and multidimensional nature of this phenomenon. Drivers' decisions to disengage from or avoid automated systems are influenced by factors such as trust, perceived safety, usability, and situational contexts. Interviews are well-suited to capturing these subjective experiences, allowing participants to articulate their perspectives and provide insights into their behavior. This qualitative approach enables a detailed examination of behavioral patterns and interactions between drivers, technology, and environmental conditions. Furthermore, the open-ended structure of interviews allows for exploring emergent themes and unanticipated insights, contributing depth and nuance to the findings. By focusing on participants' lived experiences, this method addresses a gap in empirical research, complementing the largely theoretical frameworks in the existing literature. The resulting insights enhance our understanding of the underlying decision-making processes and situational triggers for disuse, providing valuable information to improve the design and usability of ADAS. This section outlines the participants, procedures, and analytical methods utilized in the study.

2.1. Participants

A total of 35 drivers participated in the interviews. Participants were recruited via the recruitment agency userinterviews.com to access participants with experience with SAE Level 2 partial driving automation systems in the United States. They had to be 18 years or older and have experience driving a vehicle with both Adaptive Cruise Control (ACC) and Lane Keeping Assist (LKA) activated simultaneously for over six months. Among the 35 participants, 18 were female, and 17 were male. The participants ranged in age from 24 to 62 (Average = 41.8 years, SD = 10.0).

2.2. Procedure

First, to ensure a selection of candidates for the sample, participants were asked to complete screener questions (Gender, Age, Car brand, Driving experience) before the online interview. After selecting the candidates, participants received a link for an online interview. The interviews were conducted via Zoom. At the start of the interview, participants were asked to provide informed consent to participate in the study. The study was approved by the Human Research Ethics Council. For this study, we used the following questions regarding the usage of ADAS: * *Do you have an experience where the features do not work properly?* * *Do you use the function all the time? / Do you disengage ADAS?* **When do you prefer to drive manually?* * *How do you use ADAS on the road, such as in a school zone or construction area?* After the interview, participants received a $15 electronic voucher for participation.

2.3. Data analysis

The step-by-step process for thematic analysis proposed by Braun and Clarke (2023) was used. Thematic analysis is a qualitative research method that emphasizes in-depth analysis and interpretation of data. Compared to other analytical methods, such as content analysis, thematic analysis helps uncover latent meanings and patterns within research data. The analytic purpose of thematic analysis is to represent contextual interpretations of data rather than to assume that inherent meaning can be discovered in a data set. This involves familiarizing researchers with the data, generating initial codes, searching for themes, reviewing, defining, and naming them, and finally writing the analysis. Regarding sample size, due to the nature of thematic analysis aimed at contextual interpretation, it is challenging to estimate the sample size a priori (Wutich et al., 2024). However, based on the time and resources available for this study, as well as a reference to sample sizes in similar interview studies (Lin et al., 2018; Ulahannan et al., 2020; Wilson et al., 2020), we set a lower and upper limit between 20 and 35 participants, ultimately conducting interviews with 35 participants. The recorded data were analyzed using ATLAS.ti ver. 23.2.1. After the familiarization stage, codes were generated from the interview data related to driver learning strategies. Consistent with reflexive thematic analysis, themes were developed based on central organizing concepts identified from the relevant codes to capture the shared meanings among participants. The initial clustering of codes related to disuse resulted in three main themes: driven by a mismatch of driving tasks (Driving task), drivers' internal processes (Human), and driving environment (Environment). Each main theme included sub-themes that described observed characteristics. In this study, we did not focus on the number of themes drivers mentioned as important in improving their understanding and experience with automated vehicles, but on how these themes were described among participants and how such narratives explain driver behavior.

3. Results

We organized our findings around nine themes, developed under three overarching categories: 'Driving task,' 'Human,' and 'Environment.' As shown in Fig. 1, each category and its themes explore the factors influencing the disuse of advanced driver assistance systems (ADAS), identifying drivers' varied perceptions, preferences, and responses to different system interactions. The results explain how each theme, categorized under human, driving task, and environment, contributes to disuse. Note that various themes interact to influence the disuse of ADAS collectively. Each theme provides insights based on participant quotes.

3.1. Driving task

The "Driving task" category examines the performance of ADAS, drawing on Michon's hierarchical model (Michon, 1985) of driving tasks, which categorizes driving tasks into three levels: strategic, tactical, and operational. While the framework was not deliberately employed as the basis for analysis, participant descriptions of their experiences with automated systems revealed patterns that naturally aligned with this structure. Strategic tasks involve pre-trip planning and decision-making, tactical tasks relate to real-time adjustments during driving, and operational tasks concern the physical execution of vehicle control.

3.1.1. Theme 1 – Strategic level driving tasks

In automated vehicle navigation, there is a gap between the automated vehicle's strategic routing decisions and drivers' personalized route preferences. While automated vehicles generally prioritize the most efficient route, typically the fastest or shortest, drivers sometimes seek routes that offer a blend of familiarity, scenery, and comfort. Automated vehicles' focus on efficiency thus overlooks situational factors and user intentions that might otherwise play a central role in a driver's route choice. The following comment provides an example of this perception.

I don't like the route it's taking when I type the address on the GPS. I found better ways. Let's say there's a neighborhood that I like. When you enter an address, it (car) will give you one route. Usually, the fact is the quickest one. And then it would depend on the traffic. But sometimes I like a specific route –I like to go to residential because I like these houses too. I like the park or the woods. I will go to the woods instead. (P27).

Additionally, participants mentioned that automated vehicles did

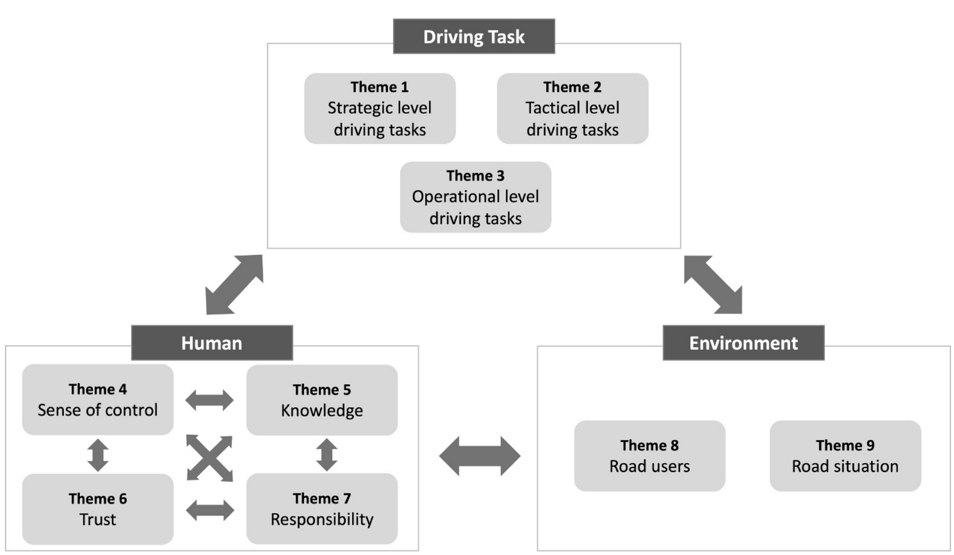

Fig. 1. Schematic representation of the themes.

not respond accurately to real-time changes in infrastructure, such as new road construction or unlisted exits, further complicating route adaptability. This limitation in navigation accuracy increases frustration when automated vehicles need to adjust to road changes promptly, creating potentially unsafe or inefficient navigation experiences. The comments below demonstrate these perceptions.

There have also been instances on Google Maps where if you're putting in directions to a location and there's been construction, new construction, this recently just happened; it didn't recognize the new exit number. So it didn't get over in the lane like it was supposed to in order to make the exit. (P34).

3.1.2. Theme 2 – Tactical level driving tasks

Participants expressed dissatisfaction with ADAS in densely populated urban settings. Specifically, the high frequency of intersections, traffic signals, and pedestrian crossings in city driving increased the need for drivers to assume control, particularly in managing Adaptive Cruise Control (ACC) settings. Participants reported that continuously activating and deactivating ACC at each traffic light or intersection not only failed to reduce the workload but actually increased it. They further noted the limitations of automated vehicle technology in detecting stop signs, requiring manual braking followed by reactivating the system, which led to its limited use in urban environments. The comments below demonstrate the different attitudes that were reported.

I don't ever really use adaptive cruise control (in the city) because what's the point if you're going like there's a stoplight every single block or if there's people crossing the street. (P23).

I think it would be more annoying to me than anything because you stop, you start, there's a light, you have to stop. (P11).

So, adaptive cruise control doesn't detect stop signs. I could hit the brake to slow down to go to a stop sign and then I could hit the button to resume to go back to my speed. But I'm literally going block to block, very short block. So it doesn't make sense to put it on. (P9).

3.1.3. Theme 3 – Operational level driving tasks

Participants described a distinct divide in their experiences with the automated driving system's operation. Some found that automated vehicles' aggressive handling, such as accelerating or braking abruptly or making last-minute lane changes, caused discomfort or even feelings of insecurity.

Several participants mentioned that the automated driving system's approach was overly aggressive in particular scenarios. They noted instances where the system would take corners or navigate curves at excessive speeds, especially on off-ramps, causing them to feel a lack of control. Such actions were reported as unsettling and occasionally uncomfortable, with the rapid acceleration and deceleration inducing physical discomfort, including symptoms of motion sickness. Users expressed that these aggressive tendencies detracted from the sense of safety and comfort, pushing them to override the system, especially in complex driving situations frequently. The comments below demonstrate the different attitudes that were reported.

When the self-driving maneuver where I don't think I would have driven that way. So for instance, you're going on an off-ramp and it's curved. Sometimes I believe that the speed that's set is too fast and it seems like it's going reckless. (P14).

Sometimes it's just an uncomfortable ride where especially on street driving where it will accelerate too fast or stop too fast. And then it makes me car sick. (P28).

I'm usually a little bit worried is like the placement of the car sometimes and then the decisions. So,ah, also the last minute decisions are a little worried sometimes when they say I'm on the far left lane and I have to exit. the car does it like pretty late. Like that's what I noticed. They just do it because they know they can get out of it pretty fast. But for me, I would do it earlier. I would change lane earlier than the computer. (P21).

My car went out the intersection … There's this one other car that was coming up the road that I personally would have waited for. But my Tesla said, now I'm going for it. And so, and it didn't cut them off or anything. It was not a dangerous situation, but it was a little more aggressive than I would have done. (P30).

Conversely, the system was also observed to be excessively conservative, which posed a different set of challenges. Participants highlighted that, at four-way stops or intersections, the system often hesitated and proceeded more cautiously than necessary, resulting in delays that caused discomfort or embarrassment. The slower decision-making process could lead to frustration for both the user and surrounding drivers, as the automated vehicle's lag in responding promptly to traffic cues caused users to worry about holding up traffic or appearing hesitant. For some, the conservative nature of the automated vehicle became particularly inconvenient when they were under time pressure, as the system's default to conservative, cautious driving conflicted with the need for more efficient, slightly faster travel. Users mentioned that when pressed for time, they preferred to disengage the automated system to manually control the vehicle, allowing them to drive at a pace that better suited their situational needs. This is demonstrated in the comments below.

I get nervous when it goes when I get to a four way stop intersection, it can handle it but it has to it will take it's slower than a human. So I don't want to upset people and wait for the computer to do it. (P4).

It would be my me turning off full self driving is not does not have to do with safety as much as it has to me being maybe "concerned that the cars around me think that I'm driving that way" when that's not how I drive (P33).

I'm on late for something, I need to get someplace quickly. if you push it, it'll go over the speed limit, but just by default, it (Car) wants to drive very conservatively, very kind of… slowly and carefully. So if I'm late for something, I'll take over and do it myself. (P32).

3.2. Human

The 'Human' category explores drivers' decisions through interactions with automated vehicles, including their sense of control, knowledge and understanding of the system, trust, and responsibility.

3.2.1. Theme 4 – Sense of control

Drivers' sense of control can be a reason for favoring manual driving over automated driving. Some participants preferred maintaining a sense of agency. In addition, participants mentioned that they turned the function off since they did not feel they needed assistance from the ADAS. The below demonstrates the reported different attitudes.

When you turn that on (driving professional), the car is essentially just driving itself. Like you really don't have to be doing anything. And I don't like giving total control to the vehicle driving itself. (P10).

I feel that I don't need the assistance. (P13).

I don't feel comfortable letting that car make that decision for me. (P34).

Furthermore, participants expressed enjoyment and satisfaction in personally managing their vehicle's actions. While drivers use ADAS on long trips to reduce tiredness, some participants get enjoyment from driving tasks themselves.

I enjoy driving. So, I don't use it (ADAS) regularly. I use it sometimes. We use it maybe for longer trips. (P17).

3.2.2. Theme 5 – Knowledge

Participants indicated that they lacked confidence in the automated vehicle's abilities due to the lack of understanding of the system's sensory and operational range. Participants mentioned that they felt uncertain about the vehicle's response range or ability to handle certain turns or road conditions effectively. This lack of clarity regarding the automated vehicle's capability in unfamiliar areas made drivers hesitant to rely solely on automated vehicles in these contexts. The uncertainty was particularly pronounced in situations involving poor visibility, complex road designs, or unique environmental challenges. The following comments demonstrate the reported different attitudes.

Where it's really hilly or curved. I know the car can see where it's coming *up, but I personally don't know how far of a range it can see. If it goes into the mapping software and it goes into the camera views or whatever, then I'd probably feel a little bit better about it. (P31).*

If I know where I'm going, I usually have the full self-driving because I know where the car should be doing. But if it's a new destination that I'm going to, I'll maybe have the full driving system like on until the middle of my trip. And then once I have to figure out where to go, then I'll probably turn it off. (P35).

3.2.3. Theme 6 – Trust

Another theme that emerged was distrust of ADAS. Distrust is a significant theme, with many participants expressing concerns over the automated driving system's ability to detect, react, and make decisions.

Participants reported a persistent distrust in automated vehicle systems' detection, reaction, and decision-making abilities, expressing reservations about the vehicle's capacity to handle unpredictable or complex driving environments. Specifically, participants were concerned about automated vehicles' detection capability, fearing that the system might not respond effectively in critical moments, such as school zones or construction areas. The comments below demonstrate the different attitudes that were reported.

I don't think technology right now can't detect how fast kids will run out into the street. (P35).

They (cars) have to change lanes because one lane is closed on the side I don't know if Tesla knows that it's doing road work on the left lane if to like change onto the right lane so that's when I usually turn it off. (P35).

I think that the car just needs better read on like situations and overall. (P25).

I'm worried about my car sensing (on rainy day). (P9).

In those areas (construction, school zone), there's more things that could kind of pop up, right? So a school zone, a kid could come out and fall into the street or something like that. A construction zone, that's usually you're kind of like going like, you know, back and forth, like weaving through things that I'm not sure a computer could like see or understand very well. (P16).

Participants expressed concerns about the automated vehicles' reaction capabilities and decision-making when navigating traffic congestion or other high-risk scenarios. Some participants felt uneasy about the vehicle's performance during complex maneuvers, such as changing lanes on congested highways, with a prevailing sentiment that human judgment is essential to handle these intricate situations effectively. Participants preferred to retain control in areas requiring heightened awareness like freeway exits or intersections, where judgment on timing and situational awareness is critical. In particular, the perception of the automated vehicles as potentially slow or overly rigid in its decision-making highlighted a sense of unease, reinforcing drivers' feelings of personal responsibility and control, often leading them to revert to manual driving. This distrust extended beyond high-risk scenarios to tasks requiring efficiency, like navigating through traffic congestion, where drivers felt they could outperform the automated vehicles. The comments below demonstrate these perspectives.

I'm on the freeway and I will let it go street surface, but in certain areas I will shut it off because I'm a little bit emotionally nervous…. It's probably just the perception that it's not going to do something that I want it to. (P14).

I'm afraid that the AI is not gonna, the computer is not gonna be able to change lane correctly. (P27).

I live in Los Angeles and the traffic in the roads. it makes for difficult driving, even for humans. And… I think that the full self-driving beta is not quite there yet in terms of its technology. (P28).

I don't know that I could like trust my car over my own decision making skills in those areas….. I would do like I would prefer to be in control in those situations. (P15).

I kind of have a feeling that I could do it better (on the freeway). So because when there is a lot of traffic, right? I think I could go side road. I could do, I believe that I could be better and I could get to my destination faster. (P29).

3.2.4. Theme 7 – Responsibility

Some participants preferred direct control over managing associated responsibilities and potential outcomes. The reasons for responsibility can be divided into legal and moral aspects.

From a legal responsibility perspective under current system-level driving, participants emphasized the need to understand the capabilities and limitations of automation systems when utilizing them. Even if an automated driving system causes an accident due to its error, participants acknowledge that they are legally responsible. The comments below demonstrate these perspectives.

If you were driving the car, you would have to take responsibility because you're putting this trust into this software; it's kind of like a robot driving. So, if the robot makes a mistake, it's your fault. (P35).

I'm still responsible for driving under current law, right? So, I would prefer to be able to take control … I do not want just to be responsible for, I mean, killing someone, or so I would better be hands-on. (P29).

However, legal responsibility alone does not solely dictate drivers' disuse of ADAS. Even under hypothetical scenarios where participants assume no legal responsibility for safety–critical incidents at a higher system level of driving, participants mentioned preferring direct control, citing moral responsibility. In particular, participants stressed that responsibility could not be transferred to automated systems when other human safety is compromised.

So it'll be able to see the car will be able to see more than I can … (but) I'm just trying to be overly cautious because if something happens, it's still my fault. I can't blame the car. (P25).

Even if I was under full self-driving, I still feel like I am responsible for the damage that was caused to that property. … I can't imagine how heavy it would weigh on my conscience if a child was struck because I was doing something else with my hands, and something happened with the vehicle. (P31) .

3.3. Environment

The 'Environment' category highlights the influence of the external driving environment on automated vehicle performance, focusing on interactions with other road users and specific roadway situations. Note that while several views from this category may stem from a general distrust in automated technology's detection and reaction capabilities, participants specifically highlighted driving environments. Consequently, disuse in these situations likely reflects a combination of general technological skepticism and specific situational factors, warranting a separate thematic focus.

3.3.1. Theme 8 – Road users

Participants mentioned the challenges posed by high pedestrian traffic, dense urban settings, and varied road users, which often made them uncomfortable using ADAS. In areas like school zones, city streets, or high-pedestrian environments, participants frequently took manual control, citing the unpredictability of children, cyclists, and pedestrians as factors the ADAS might not adequately manage. The frequent presence of erratic behaviors by other road users created unease, as drivers felt that ADAS might not sufficiently anticipate or avoid sudden actions, such as a pedestrian stepping into the street unexpectedly. The comments below demonstrate the different attitudes that were reported.

I don't trust kids. Just like my kids they will run across the street without looking if there's cars. (P35).

Cause at that, that you run into more pedestrians, you run into more animals, you run into people running red lights, things like that where I would rather have… Yeah, red lights a great example, because in this city people aren't paying that much attention. So even when the light changes, I like to wait a couple seconds before going. (P31).

There's so many people here that walk out in front of your car… I see that the people are a lot worse. It's the people driving. It's the people walking. It's random cats around the neighborhood. (P9).

I'm just scared. In New York, you just have like bikers coming out of *nowhere and like, they could just come out of like, that's why I use it only on highways. (P26).*

There's a lot of construction so you don't want hit a construction worker or something. (P23).

I would take over because typically like in a construction zone, you're going to have like workers in the street. And so hitting a car is one story, hitting a human is another, right? (P30).

3.3.2. Theme 9 – Road situation

Participants reported challenges when driving through complex road situations, including construction zones, narrow streets, and intersections. In construction zones, participants often felt the ADAS inability to adjust adequately to temporary road markings, cones, or other barriers, leading to situations where the system misinterpreted lanes or attempted to follow default markings, creating safety concerns. Similarly, intersections and narrow roads were frequently cited as areas where the ADAS struggled with proper spatial orientation or decision-making, such as when maneuvering around large trucks or navigating through unusually tight lanes. Participants were thus inclined to take over in these instances, perceiving manual intervention as necessary to ensure smooth and safe navigation through these complex and often unpredictable driving scenarios. The following comments demonstrate these perceptions.

There was just a cone on the side of the road, but it was a construction area. The car actually started going through the construction area and luckily I was able to gain control really quickly, turning off FSD and all that. (P25).

If they have cones and they're trying to block off traffic or redirect traffic, the car keeps sensing the lines. And so it senses that I'm not in the correct lane. So it'll try to make me three steer. And I'll have to keep I'll have to just flash on my signal just so that it'll disengage that feature and it'll let me manually do what I want with the car. (P12).

Most accidents happen in intersections. So I'm a little, you know, a little more wary, a little more concerned. Intersections are harder to deal with, obviously. (P30).

I definitely take control sometimes. Especially, I think I take control when it's very narrow, when the road lane is like in Europe, it's very narrow … if it's like starting to be very close to other cars, or close to the curb, then I will take control. (P27).

4. Discussion

This study investigates the factors influencing drivers' decisions to disengage from advanced driver assistance systems (ADAS), highlighting the complex interplay of vehicle performance, human behavior, and environmental conditions. Rather than being driven by a single determinant, the disuse of these systems emerges from systemic interactions across these domains. The findings, organized into nine themes within three overarching categories – 'Driving task,' 'Human,' and 'Environment' – offer a comprehensive understanding of the factors shaping drivers' experiences and choices.

Understanding why ADAS are underused is important to improving road safety. These systems aim to reduce human error, enhance hazard detection, and improve response times. Disengagement or avoidance weakens their safety benefits, raising collision risks and disrupting V2V and V2I communication, which depend on real-time data to enhance traffic safety. By identifying the systemic and contextual factors driving disuse, this study provides critical insights for designing more adaptive, transparent, and user-centered ADAS that address these barriers. These findings foster trust and engagement, ultimately supporting the broader adoption of automated vehicles and their potential to save lives and prevent accidents. The following sections discuss key findings and their implications.

4.1. Calibrating the performance of ADAS for safety and user experience

The results highlight a misalignment between ADAS design priorities and drivers' expectations. While most ADAS prioritize efficiency, drivers expect a more personalized, adaptive experience that responds to situational context. For example, automated vehicles tend to optimize routes based on data related to speed and distance, but drivers may prefer routes that offer scenic views, a sense of mental ease, or personally meaningful experiences. This disparity points to a fundamental gap in current automated vehicle design. Effective automated vehicles need to address not only functional concerns but also align more closely with subjective needs and emotional nuances. Recent studies on automated driving route algorithms and frameworks suggest incorporating driver preferences (Neidhardt & Suske, 2021; Wang et al., 2021), yet further research is required to assess the impact of such driver-centered routing strategies. Additionally, giving drivers more freedom in routing decisions could result in suboptimal outcomes in terms of safety and security. For instance, drivers might use this flexibility to select routes that avoid police presence, a behavior documented in various studies (Truelove et al., 2023). This could increase risks in less-monitored areas and lead to decisions prioritizing personal interest over public safety.

Many participants reported discomfort with specific tactical and operational behaviors of ADAS, such as frequent overrides, unintended acceleration, or delayed lane changes. In urban environments with frequent crosswalks, drivers note repeated on/off cycling of Adaptive Cruise Control (ACC), leading them to switch off the system eventually. Current ACC technology appears to increase rather than alleviate driver workload in these scenarios. Therefore, developing driving automation that effectively manages intermittent braking demands, such as stop-and-go situations after crosswalks, could improve the usability of ADAS. However, addressing these issues requires careful consideration of behavioral adaptation and road safety. As drivers become accustomed to ADAS, they may reduce active monitoring of the road, which could diminish situational awareness and reaction time in unexpected situations, referred to as negative behavioral adaptation. For example, previous research showed that negative behavior adaptation occurs due to Automatic Emergency Braking (AEB) (Kinosada et al., 2021) or Forward Collision Warnings (FCW) (Reinmueller & Steinhauser, 2019), such as decreasing self-protective driving. In the case of ACC usage, it can lead to delayed reactions to hazardous events (Rudin-Brown & Parker, 2004; Shen & Neyens, 2017) and decreases in time-to-collision (Piccinini et al., 2015). This behavioral adaptation poses a safety risk if drivers assume automation will detect all potential hazards, leading to reduced vigilance. To mitigate these risks, ADAS should not only improve their urban processing capabilities but also integrate features that encourage driver engagement and awareness of the surrounding environment. Additionally, a balanced approach that enhances usability while maintaining driver alertness is essential for supporting road safety.

Furthermore, participants often perceive ADAS as either overly aggressive or excessively conservative. For example, behaviors like high-speed sharp turns, late lane changes, and abrupt decelerations can lead to discomfort and even motion sickness among some passengers. Such aggressive maneuvers can negatively impact the system's acceptability due to perceived safety risks. On the other hand, overly cautious behaviors, such as excessive hesitation at four-way stops, can also disrupt the driving experience, causing frustration or confusion among drivers. This highlights a challenge in balancing assertiveness and caution in automated vehicle decision-making. While addressing overly conservative and aggressive driving behaviors is critical, these adjustments must prioritize safety. Overly aggressive systems increase the risk of collisions and unexpected maneuvers, potentially eroding passenger trust (Ma & Zhang, 2021). Similarly, overly conservative systems may hesitate at key moments, leading to irregular traffic flow and potential confusion for human drivers. Furthermore, drivers do not seek a consistent driving style but prefer different styles depending on the driving situation (Lee et al., 2024; Peintner et al., 2024). Therefore, it is necessary to adjust the driving style to match both the context and the driver's preferences. Therefore, any adjustments to automated vehicle behavior should optimize driver comfort and road safety, promoting safe interactions and effective integration with human-driven vehicles on the road.

4.2. Designing transparency for enhancing understanding and trust in the ADAS

Participants repeatedly mentioned distrust in ADAS due to concerns regarding detection, reaction times, and decision-making processes. In conditions requiring heightened sensitivity, such as pedestrian-heavy intersections, school zones, or construction sites, drivers often preferred manual control, worried that the ADAS might not respond appropriately or promptly. Interestingly, it was not merely a lack of trust in the technology itself but also a lack of knowledge about the system's capabilities that contributed to disuse. This gap in trust and understanding can be attributed, in part, to a lack of transparency in ADAS. Therefore, automated vehicles should enhance the detection and responsiveness technology in complex settings and provide transparency. One solution is developing user interfaces that inform drivers about the system's information, which can help reduce uncertainty and mitigate drivers' distrust. For example, real-time information about the vehicle's perception of its surroundings, intended actions (Basantis et al., 2021; Kim et al., 2024; Ma et al., 2021), and system capability (Helldin et al., 2013; Kunze et al., 2019) can increase trust and acceptance. Augmented displays or verbal prompts that convey system boundaries and real-time status could further enable users to anticipate systems' actions (Oliveira et al., 2020; Sawitzky et al., 2019) better, making it easier for them to make informed decisions on when to intervene, thereby reducing unnecessary disengagement from the system.

The environment in which automated vehicles operate substantially influences drivers' attitudes and decisions related to system engagement. Participants frequently express concerns about automated vehicles' ability to handle unpredictable behaviors of other road users, such as pedestrians, cyclists, and animals, particularly in dense, high-traffic areas. To address these concerns, we can suggest that technological improvements in automated vehicles are needed, such as advancing predictive algorithms to better anticipate human behavior in highly interactive zones. Beyond technical advancements, however, additional strategies are needed to enhance perceived safety for drivers in these environments. For example, transparently communicating automated vehicle actions and decisions through the user interface, as mentioned above, allows drivers to see real-time hazard predictions and planned responses. By increasing users' awareness of the decision-making processes, drivers can gain confidence in the system's reliability and safety, even in complex environments.

The findings highlight the systemic factors influencing the disuse of ADAS, emphasizing the intertwined roles of technological limitations and user perception. Distrust in automated systems often stems from concerns about their ability to detect and respond effectively in complex and dynamic environments, such as school zones, intersections, or construction sites. This distrust is compounded by a lack of transparency and user understanding of the system's operational boundaries and capabilities. Enhancing predictive algorithms to better anticipate human behavior in high-interaction zones is essential for addressing technical gaps. Equally important is fostering trust through user interfaces that provide real-time insights into the vehicle's perception, decision-making, and planned actions. Transparent communication of these processes can help reduce uncertainty and improve user confidence in system reliability, mitigating unnecessary disengagement and supporting more consistent use of automated driving technologies. A trust-based approach should be context-dependent, acknowledging that user acceptance varies across different environments and situations. Transparent and adaptive communication of system processes, tailored to specific driving scenarios, can reduce uncertainty, foster confidence, and mitigate unnecessary disengagement.

4.3. Balancing automation and human engagement

Many participants expressed reluctance to use ADAS, particularly in challenging or high perceived-risk situations where they felt their judgment and reflexes could outperform automated decisions. This preference for manual control reflects an underlying value many drivers place on personal agency, which can be at odds with the passive role imposed by ADAS. In addition, for some drivers, the act of driving itself is enjoyable, further diminishing the appeal of fully automated systems. These findings highlight the complexity of developing ADAS that balance technological capability with human factors, ensuring drivers feel comfortable and confident in their interactions with automation.

A notable finding of this study is that perceptions of responsibility influence attitudes toward ADAS. Participants emphasized the importance of understanding system limitations and capabilities, expressing a desire to manage legal responsibilities. Under current legal frameworks, drivers remain accountable for accidents (Kubica, 2022), even if caused by automation errors, encouraging them to stay actively involved in vehicle operations. Beyond legal concerns, moral responsibility also emerged as a critical factor. Drivers believed that responsibility for human safety could not be ethically delegated to automated systems, particularly in scenarios involving potential harm to others. These attitudes highlight the need to design ADAS that enable drivers to exercise control even at higher levels of driving automation. Even in situations where driver engagement is not technically required, the necessity of designing systems that encourage driver involvement is shown by the desire for a sense of control. Many participants reported discomfort with relinquishing full control to automated systems, reflecting a strong preference to remain actively engaged in vehicle management. Some drivers even deactivated automation functions, citing a lack of perceived need for assistance or discomfort with delegating decision-making to the system. This underscores the challenges of designing systems that cater to drivers' psychological needs for control and their preference for active involvement.

These findings suggest the degradation of driving automation levels to accommodate drivers' needs for control and engagement. Interactions with automated vehicles have primarily been designed from a technology-centered perspective. This means that automated vehicles are built to leverage the latest advancements and offer the highest levels of automation. However, drivers may prefer lower levels of automation, where they can remain actively engaged in the driving process rather than relying entirely on highly automated driving options. For example, in dense traffic areas or unpredictable pedestrian zones, the automated vehicles could shift from full driving automation to a lower level of driving automation, requiring more driver input. This controlled degradation could foster user engagement, providing drivers with greater control in environments where perceived risk is high. Additionally, such an approach might help address any residual trust issues by emphasizing human oversight in situations where full driving automation might feel overly detached or unresponsive. A flexible interaction that empowers drivers to shift between manual and automated modes without abrupt disengagement and seamless re-engagement could enhance the user experience and encourage more consistent adoption of automated vehicles. However, this approach can increase driving mode confusion. Therefore, the explicit user interface supports awareness of the current mode.

4.4. Limitations and future research

This study provides valuable insights into drivers' disuse of ADAS. However, several limitations impact the generalizability and depth of the findings, highlighting important directions for future research. Firstly, qualitative analysis offers rich and detailed insights, but it limits the generalizability of results. The thematic analysis focused on in-depth exploration within a small sample rather than statistical representation. Additionally, the study sample may not fully represent the broader automated vehicle driver base, as it lacked demographic diversity in age, gender, geographic location, and socioeconomic status, factors that may influence experiences and perspectives on ADAS. Future research should aim for a broader and more diverse sample, including younger drivers, individuals from various regions, and those of different income levels, to achieve a more comprehensive understanding of the usage. Secondly, the study is based on experiences with SAE Level 2 automated vehicles, which may not fully reflect behavior with more advanced levels of driving automation. Improvements in technology may lead to greater adoption of previously unused features. As SAE Level 3 automated vehicles plan to come to market soon, it will be necessary to investigate how driver behavior and patterns evolve with highly ADAS. Additionally, participant accounts are subjective, relying on their perceptions and recollections rather than objective measurements. This reliance on self-reported data can introduce biases, such as recall bias, particularly in high-risk scenarios like driving through school zones or construction areas, where memories may not accurately reflect actual driving time or behavior. Future studies could strengthen these findings by triangulating self-report data with empirical measurements, such as in-vehicle monitoring systems or real-time data logs, to gain a more robust understanding of the usage and decision-making. Lastly, this research did not assess the potential influence of specific automotive brands or models, despite the fact that different manufacturers may implement unique automated features and design approaches. Future studies could explore how brand-specific design characteristics contribute to user acceptance or disuse. Such research could offer actionable insights for automakers seeking to meet user expectations and address barriers to adoption. These limitations suggest promising directions for future research, including expanding sample diversity, integrating quantitative methods, incorporating objective performance data, and examining brand-specific factors to better understand automated vehicle interaction and acceptance.

5. Conclusion

This study provides a comprehensive analysis of the reasons behind the disuse of advanced driver assistance systems (ADAS) among drivers of partially automated vehicles, offering critical insights with significant design implications. The findings underscore the need for adaptive, user-centered designs that go beyond traditional priorities of efficiency and safety to accommodate individual preferences and the complexities of varied driving contexts. The study highlights the role of transparency in fostering trust and engagement, emphasizing the need for clear and intuitive communication about system capabilities, limitations, and real-time decision-making processes. Additionally, the research underscores that automated systems must be perceived as context-aware and flexible, capable of adapting to diverse environments and situational demands. This adaptability is particularly important in complex driving scenarios where trust in the system's performance is closely tied to its ability to anticipate and respond to human behaviors and environmental variability effectively. The interplay between psychological, technological, and environmental factors revealed in this study suggests that achieving widespread adoption of automated vehicles will require prioritizing designs that empower users, address context-specific needs, and provide transparent, dynamic interaction with the system. By addressing these multifaceted challenges, future automated vehicle designs have the potential not only to foster greater trust and user comfort but also to play a pivotal role in accident prevention, ultimately advancing safer and more effective integration of automated vehicles into everyday driving practices.

CRediT authorship contribution statement

Soyeon Kim: Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation, Conceptualization. **Oscar Oviedo-Trespalacios:** Writing – review & editing, Validation.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Soyeon Kim reports financial support was provided by Europe Horizons. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The data for this study was collected with funding from the European Union's Horizon 2020 research and innovation program, under the Hi-Drive project (No. 101006664). The dataset has been published and can be accessed through the following link: https://doi.org/10.4121/f833cdf7-4018-4abd-8f5b-f108842a3033. The sole responsibility of this publication lies with the authors.

References

Azevedo-Sa, H., Zhao, H. J., Esterwood, C., Yang, X. J., Tilbury, D. M., & Robert, L. P. (2021). How internal and external risks affect the relationships between trust and driver behavior in automated driving systems. *Transportation Research Part C-Emerging Technologies, 123*. https://doi.org/10.1016/j.trc.2021.102973

Barki, H., & Hartwick, J. (1994). Measuring User Participation, User Involvement, and User Attitude. *Mis Quarterly*, *18*(1), 59-82. https://doi.org/Doi 10.2307/249610.

Basantis, A., Miller, M., Doerzaph, Z., & Neurauter, M. L. (2021). Assessing Alternative Approaches for Conveying Automated Vehicle "Intentions". *Ieee Transactions on Human-Machine Systems, 51*(6), 622–631. https://doi.org/10.1109/Thms.2021.3106892

Braun, V., & Clarke, V. (2023). Toward good practice in thematic analysis: Avoiding common problems and be(com)ing a researcher. *International Journal of Transgender Health, 24*(1), 1–6. https://doi.org/10.1080/26895269.2022.2129597

Carsten, O., & Martens, M. H. (2019). How can humans understand their automated cars? HMI principles, problems and solutions. *Cognition Technology & Work, 21*(1), 3–20. https://doi.org/10.1007/s10111-018-0484-0

Chiou, E. K., & Lee, J. D. (2023). Trusting Automation: Designing for Responsivity and Resilience. *Human Factors, 65*(1), 137–165. https://doi.org/10.1177/00187208211009995

Delmas, M., Camps, V., & Lemercier, C. (2023). Should my automated car drive as I do? investigating speed preferences of drivengers in various driving conditions. *PLoS One1, 18*(2), Article e0281702.

Endsley, M. R. (2023). Supporting Human-AI teams: Transparency, explainability, and situation awareness. *Computers in Human Behavior, 140*, Article 107574.

Gershon, P., Mehler, B., & Reimer, B. (2023). Driver response and recovery following automation initiated disengagement in real-world hands-free driving. *Traffic injury prevention, 24*(4), 356–361.

Hancock, P., Billings, D., Schaefer, K., Chen, J. Y. C., Visser, E., & Parasuraman, R. (2011). A meta-analysis of factors impacting trust in human–robot interaction. *Human Factors, 53*, 517–527.

Hancock, P. A., Nourbakhsh, I., & Stewart, J. (2019). On the future of transportation in an era of automated and autonomous vehicles. *Proceedings of the National Academy of Sciences 1*.

He, X., Stapel, J., Wang, M., & Happee, R. (2022). Modelling perceived risk and trust in driving automation reacting to merging and braking vehicles. *Transportation Research Part F-Traffic Psychology and Behaviour, 86*, 178–195. https://doi.org/10.1016/j.trf.2022.02.016

Helldin, T., Falkman, G., Riveiro, M., & Davidsson, S. (2013). Presenting system uncertainty in automotive UIs for supporting trust calibration in autonomous driving. *5th international conference on automotive user interfaces and interactive vehicular applications*.

Hoff, K. A., & Bashir, M. (2015). Trust in Automation: Integrating Empirical evidence on Factors that Influence Trust. *Human Factors, 57*(3), 407–434. https://doi.org/10.1177/0018720814547570

Jiménez, F., Naranjo, J. E., Anaya, J. J., García, F., Ponz, A., & Armingol, J. M. (2016). Advanced driver assistance system for road environments to improve safety and efficiency. *Transportation research procedia, 14*, 2245–2254.

Kelly, S., Kaye, S. A., & Oviedo-Trespalacios, O. (2023). What factors contribute to the acceptance of artificial intelligence? *A systematic review. Telematics and Informatics, 77*, Article 101925.

Kenesei, Z., Ásványi, K., Kökény, L., Jászberényi, M., Miskolczi, M., Gyulavári, T., & Syahrivar, J. (2022). Trust and perceived risk: How different manifestations affect the adoption of autonomous vehicles. *Transportation research part A: Policy and practice, 164*, 379–393. https://doi.org/10.1016/j.tra.2022.08.022

Kim, S., He, X., van Egmond, R., & Happee, R. (2024). Designing user interfaces for partially automated vehicles: Effects of information and modality on trust and acceptance. *Transportation research part F: Traffic psychology and behaviour, 103*, 404–419. https://doi.org/10.1016/j.trf.2024.02.009

Kinosada, Y., Kobayashi, T., & Shinohara, K. (2021). Trusting other vehicles' automatic emergency braking decreases self-protective driving. *Human Factors, 63*(5), 880–895.

Kraus, J., Scholz, D., Stiegemeier, D., & Baumann, M. (2020). The more you know: Trust Dynamics and Calibration in Highly Automated Driving and the Effects of Take-Overs, System Malfunction, and System Transparency. *Human Factors, 62*(5), 718–736. https://doi.org/10.1177/0018720819853686

Kubica, M. L. (2022). Autonomous Vehicles and Liability Law. *American Journal of Comparative Law, 70*(Supp 1), i39–i69. https://doi.org/10.1093/ajcl/avac015

Kunze, A., Summerskill, S. J., Marshall, R., & Filtness, A. J. (2019). Automation transparency: Implications of uncertainty communication for human-automation interaction and interfaces. *Ergonomics, 62*(3), 345–360.

Lee, J. D., & See, K. A. (2004). Trust in automation: Designing for appropriate reliance. *Human Factors, 46*(1), 50–80. https://doi.org/10.1518/hfes.46.1.50.30392

Lee, Y., Dong, M., Krishnamoorthy, V., Akash, K., Misu, T., Zheng, Z., & Huang, G. (2024). Driving aggressively or conservatively? investigating the effects of automated vehicle interaction type and road event on drivers' trust and preferred driving style. *Human Factors, 66*(9), 2166–2178.

Lewis, M., Sycara, K., & Walker, P. (2018). The Role of Trust in Human-Robot Interaction. *Foundations of Trusted Autonomy, 117*, 135–159. https://doi.org/10.1007/978-3-319-64816-3_8

Lin, R., Ma, L., & Zhang, W. (2018). An interview study exploring Tesla drivers' behavioural adaptation. *Applied Ergonomics, 72*, 37–47. https://doi.org/10.1016/j.apergo.2018.04.006

Ma, R. H. Y., Morris, A., Herriotts, P., & Birrell, S. (2021). Investigating what level of visual information inspires trust in a user of a highly automated vehicle. *Applied Ergonomics, 90*. https://doi.org/10.1016/j.apergo.2020.103272

Ma, Z., & Zhang, Y. (2021). Drivers trust, acceptance, and takeover behaviors in fully automated vehicles: Effects of automated driving styles and driver's driving styles. *Accident Analysis & Prevention, 159*, Article 106238.

Merritt, S. M., Heimbaugh, H., LaChapell, J., & Lee, D. (2013). I Trust it, but I Don't know why: Effects of Implicit attitudes Toward Automation on Trust in an Automated System. *Human Factors, 55*(3), 520–534. https://doi.org/10.1177/0018720812465081

Michon, J. A. (1985). *A critical view of driver behavior models: What do we know, what should we do?* Boston, MA: In Human behavior and traffic safety.

Molnar, L. J., Ryan, L. H., Pradhan, A. K., Eby, D. W., St Louis, R. M., & Zakrajsek, J. S. (2018). Understanding trust and acceptance of automated vehicles: An exploratory simulator study of transfer of control between automated and manual driving. *Transportation Research Part F-Traffic Psychology and Behaviour, 58*, 319–328. https://doi.org/10.1016/j.trf.2018.06.004

Nandavar, S., Kaye, S. A., Senserrick, T., & Oviedo-Trespalacios, O. (2023). Exploring the factors influencing acquisition and learning experiences of cars fitted with advanced driver assistance systems (ADAS). *Transportation Research Part F-Traffic Psychology and Behaviour, 94*, 341–352. https://doi.org/10.1016/j.trf.2023.02.006

Neidhardt, E., & Suske, D. (2021). *Route planning based on street criteria for autonomous driving vehicles. 5th International Conference on Vision, Image and Signal Processing (ICVISP)*.

Nordhoff, S. (2024). A conceptual framework for automation disengagements. *Scientific Reports, 14*(1), 8654.

Nordhoff, S., Lee, J. D., Calvert, S. C., Berge, S., Hagenzieker, M., & Happee, R. (2023). *(Mis-) use of standard Autopilot and Full Self-Driving (FSD) Beta: Results from interviews with users of Tesla's FSD Bet Frontiers in psychology, 14*, Article 1101520. https://doi.org/10.3389/fpsyg.2023.1101520

Nordhoff, S., Stapel, J., He, X. L., Gentner, A., & Happee, R. (2021). Perceived safety and trust in SAE Level 2 partially automated cars: Results from an online questionnaire. *PLoS One1, 16*(12). https://doi.org/10.1371/journal.pone.0260953

Oliveira, L., Burns, C., Luton, J., Iyer, S., & Birrell, S. (2020). The influence of system transparency on trust: Evaluating interfaces in a highly automated vehicle. *Transportation Research Part F-Traffic Psychology and Behaviour, 72*, 280–296. https://doi.org/10.1016/j.trf.2020.06.001

Oviedo-Trespalacios, O. (2024). Beep, Bleep, Oops! A Discussion on the Misuse of Advanced Driver Assistance Systems (ADAS) and the Path Moving Forward. In 10th International Conference on Vehicle Technology and Intelligent Transport Systems, VEHITS 2024,.

Parasuraman, R., & Riley, V. (1997). Humans and Automation: Use, misuse, disuse, abuse. *Human Factors, 39*(2), 230–253. https://doi.org/10.1518/001872097778543886

Peintner, J., Himmels, C., Rock, T., Manger, C., Jung, O., & Riener, A. (2024). Driving Behavior Analysis: A Human Factors Perspective on Automated Driving Styles. *2024 IEEE Intelligent Vehicles Symposium (IV)*.

Piccinini, G. F. B., Rodrigues, C. M., Leitão, M., & Simões, A. (2015). Reaction to a critical situation during driving with Adaptive Cruise Control for users and non-users of the system. *Safety science, 72*, 116–126.

Reinmueller, K., & Steinhauser, M. (2019). Adaptive forward collision warnings: The impact of imperfect technology on behavioral adaptation, warning effectiveness and acceptance. *Accident analysis & prevention, 128*, 217–229.

Rudin-Brown, C. M., & Parker, H. A. (2004). Behavioural adaptation to adaptive cruise control (ACC): Implications for preventive strategies. *Transportation Research Part F: Traffic Psychology and Behaviour, 7*(2), 59–76.

Sawitzky, T. V., Wintersberger, P., Riener, A., & Gabbard, J. L. (2019). Increasing trust in fully automated driving: Route indication on an augmented reality head-up display. *Pervasive Displays 2019–8th ACM International Symposium on Pervasive Displays*.

Shen, S., & Neyens, D. M. (2017). Assessing drivers' response during automated driver support system failures with non-driving tasks. *Journal of safety research, 61*, 149–155.

Truelove, V., Nicolls, M., Stefanidis, K. B., & Oviedo-Trespalacios, O. (2023). Road rule enforcement and where to find it: An investigation of applications used to avoid detection when violating traffic rules. *Journal of Safety Research, 87*, 431–445. https://doi.org/10.1016/j.jsr.2023.08.015

Ulahannan, A., Cain, R., Thompson, S., Skrypchuk, L., Mouzakitis, A., Jennings, P., & Birrell, S. (2020). User expectations of partial driving automation capabilities and their effect on information design preferences in the vehicle. *Applied Ergonomics, 82*. https://doi.org/10.1016/j.apergo.2019.102969

Wang, R., Zhou, M., Gao, K., Alabdulwahab, A., & Rawa, M. J. (2021). Personalized route planning system based on driver preference. *Sensors, 22*(1), 11.

Wilson, K. M., Yang, S. Y., Roady, T., Kuo, J., & Lenne, M. G. (2020). Driver trust & mode confusion in an on-road study of level-2 automated vehicle technology. *Safety science, 130*. https://doi.org/10.1016/j.ssci.2020.104845

Wutich, A., Beresford, M., & Bernard, H. R. (2024). Sample Sizes for 10 Types of Qualitative Data Analysis: An Integrative Review, Empirical Guidance, and next steps. *International Journal of Qualitative Methods, 23*. https://doi.org/10.1177/16094069241296206

Dr Soyeon Kim is a Research Scientist in the Department of Transport and Planning at Delft University of Technology. Her research covers human-centred mobility design and human factors in automated vehicles, specialising in human-machine interaction design for trustworthy automated vehicles. She has experience in both the industry and academia in the automotive field.

Dr Oscar Oviedo-Trespalacios is an Assistant Professor in Responsible Risk Management at the Delft University of Technology. His research and teaching cover the tensions between safety and sustainable development issues such as equity, fair work, and climate action. He has achieved international recognition in preventing the misuse of technology. Dr Oviedo-Trespalacios volunteers in government committees and holds editorial board/editorship positions in leading and high-impact journals such as Accident Analysis & Prevention, Transport Reviews, Transportation Research Part F: Traffic Psychology and Behaviour, & Human Factors and Ergonomics in Manufacturing and Service Industries.