Connecting Mobility

ADAS: from owner to user

Insights in the conditions for a breakthrough
of Advanced Driver Assistance Systems

Combining strenghts for future mobility

Contents

Summary

These days commercials for new cars boast various Advanced Driver Assistance Systems (ADAS). This suggests that these systems are becoming increasingly mainstream. But is this really the case? Do people actually know with which ADAS their car is equipped? And if they do, do people actually use these ADAS? Thus far, most research on the use of ADAS has been conducted with questionnaires in which participants were asked whether their car has been equipped with ADAS, and if so, whether they use these systems. The pitfall of this research approach is that it presumes that drivers are actually aware with which ADAS their car is equipped. To get a full understanding of whether drivers use the ADAS with which their car is equipped, it is essential to combine the results of aforementioned questionnaires with the vehicle specifications of participants' cars. Secondly, it is important to understand what kind of functionality drivers expect from the various types of ADAS. The current research aimed at shedding more light on the chain from ADAS owner to ADAS user and to bring a user's perspective to the various brand names that are given to similar ADAS functionalities. Insights in the full chain from ADAS owner to ADAS user are crucial for understanding the conditions for a breakthrough of ADAS usage. This is important as ADAS have the potential to increase traffic safety[1,2].

This study combined an online survey under 1,355 business drivers with the vehicle specifications of their cars. The results represent business oriented mobility in the Netherlands.

Highlights of this study

- This study combined an online survey under 1,355 business drivers with the vehicle specifications of their cars. The results represent business oriented mobility in the Netherlands .
- The lack of awareness of ownership of ADAS currently appears to be the largest bottleneck for the breakthrough of ADAS usage.
- Participants who were aware of owning a specific ADAS also displayed a tendency to use this ADAS.
- ADAS being part of the default option and ADAS added for comfort are the key factors for explaining why one's car is equipped with ADAS.
- Only 24% of the business drivers received instructions regarding their ADAS at the car dealer.
- The fact that drivers' interpretations of ADAS names deviate from the functionality intended by the automotive industry underlines that the lack of uniformity in ADAS' names and functionality is indeed a shortcoming.
- When interpreting ADAS' functionality, business drivers have difficulties distinguishing between ADAS solely capable of informing or warning the driver and those also capable of intervening in the driving task.
- Consensus or guidelines on ADAS names, symbols, their functionality, and ease of access to this information, will likely improve consumers' understanding of the ADAS with which their car is equipped and what functionality they can expect from those systems.
- Compared to the entire Dutch fleet, the cars of business drivers are both relatively new as well as expensive and are more often equipped with ADAS. Henceforth this group of drivers is likely to have more experience with ADAS.
- Not for all ADAS their availability in the car could be derived from the vehicle specifications. An example of an ADAS that could not be obtained is Intelligent Speed Adaptation (ISA).

1 The drivers and their cars

Together with RAI, VZR, VMS|Insight and Autotelex, Connecting Mobility looked into the conditions for a breakthrough of ADAS usage. For this, the current study was aimed at a specific subgroup of drivers who can be expected to be already more acquainted with ADAS: the business driver. Business drivers distinguish from other drivers, for example commuters, in that they do not just drive to and from work. Instead, for them, driving is part of their job. This is the case for, for example, not only couriers, but many consultants as well. Business drivers were of particular interest for the current study as, on average, their mileage is high compared to commuters and leisure drivers[3]. Since they spend a lot of time interacting with their car it can be assumed they know their cars better than other drivers might know theirs.

The study was carried out between March 2-10, 2017, amongst members of VZR, a Dutch interest group for business drivers. The questionnaire was send to all members of VZR and 1,393 business drivers participated in this study. For 1,355 business drivers, the online survey results could be matched with the vehicle specifications of their cars. The results of this study are representative for business oriented mobility in the Netherlands.

Business drivers in the current study either drove their lease car, their privately owned car or a company car. The retail value of 79% of the cars involved lies between €20,000 and €50,000 – with an average retail value of €39,400 – and 84% of the cars were manufactured between 2012 and 2016. An overview of all cars involved in the study is given in Figure 1. The cars involved in the study are both relatively new as well as expensive. In comparison, the average Dutch car has a retail value of €29,622[4] and is, on average, ten years old[5].

Figure 1   **Year of production of participants' cars and retail value of participants' cars.**
The amount of cars per year of production (left) and the retail value of participants' cars (right).

"Aon expects that there could be a nearly 40 percent drop in car accidents, which will result in the processing of fewer claims. However, new technology will forge new types of claims and likely more product liability claims. For understanding the risk profile of driverless cars in specific scenarios Aon will continue testing (semi) autonomous cars on the road. We as Aon need to act quickly to ensure that we have the products available to align to the new paradigm."

Evert-Jeen van der Meer. Industry Director Automotive, Aon Risk Solutions Trade & Manufacturing

2 The ADAS in question

The study focussed on sixteen ADAS that may aid smart mobility. These involved Navigation (without traffic feed), Live Navigation (with traffic feed), Cruise Control, Adaptive Cruise Control (ACC), Speed Limiter, Intelligent Speed Adaptation (ISA), Lane Departure Warning, Lane Keeping Aid, Lane Change Merge Aid, Park Assist Pilot, Emergency Brake, Distance Alert, Traffic Sign Recognition, Intersection Assistant, Cross Traffic Alert and Traffic Jam Assistant. The functional definitions of these ADAS can be found in Table 1. Based on participants' licence plate number, which was cross-checked with cars' make and model, Autotelex[a] determined with which ADAS vehicles have been equipped factory fit. Unfortunately not all selected ADAS could be included throughout the study. Firstly, Speed Limiter and Intelligent Speed Adaptation could not be derived from the vehicle specifications. Therefore we were unable to match them with the results of the questionnaire. Secondly, this match between questionnaire results and vehicle specifications could not be made for Park Assist Pilot either, due to a technical error it had not been part of the questionnaire. Lastly, the vehicle specifications did not allow for Autotelex to distinguish between regular Navigation (without traffic feed) and Live Navigation (with traffic feed), while the questionnaire in fact did distinguish between the two. To resolve this, results for these two ADAS have been tallied and are referred to as Navigation from here on, unless stated otherwise.

Apart from Cruise Control and Navigation, the ADAS in question are comparatively new. They have only become part of participants' vehicles around the year 2012. Figure 2 shows an increase in various ADAS since then. Still, on average, the percentage of participants' cars equipped with ADAS – other than Cruise Control or Navigation – may seem rather low. However, the availability of ADAS are high among the sample of business drivers in the current study in comparison with their availability in the current Dutch fleet (see Figure 3). For this comparison, the ADAS in the current study have been mapped in an overview of ADAS availability in the Dutch fleet, as reported by RAI Association[6]. They base availability of various ADAS in the Dutch fleet on sales figures of cars manufactured between January 2012 and December 2016 as provided by JATO.[b] Henceforth, the comparison only takes into account cars manufactured during aforementioned period. RAI Association assumed that before 2012 hardly any cars equipped with ADAS were sold in The Netherlands. Figure 2 suggests that, apart from Cruise Control and Navigation, this is indeed a likely scenario.

"RDW maintains the national motor vehicle registers. Although the registers contain a vast amount of data, no additional safety and comfort features (ADAS) are registered. In the time to come, RDW together with its stakeholders will explore whether the registration of additional ADAS information is necessary and possible in perspective of vehicle safety"

Ab van Ravestein. Managing Director, RDW

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[a] Autotelex is one of the market leading companies in residual value estimating and enhanced vehicle specification data. Their database enables the one-to-one license plate integration with the OEM vehicle specifications.

[b] JATO Dynamics is a global market leader in Automotive Marketing Intelligence. JATO researches 54 countries on sales volumes, specifications and prices.

Some constraints

When matching the ADAS a few constraints were encountered for which it was not possible to match all ADAS. First of all, not all ADAS names and definitions of ADAS functionality, as used by Autotelex, could be matched with names and definitions as used by JATO (on which the report of RAI Association[6] relied). In specific, used definitions in the current study of a Traffic Jam Assistant and of a Distance Alert were not reconcilable with any of the ADAS definitions used by JATO. Secondly, the ADAS that could be derived from vehicle specifications differed between Autotelex and JATO. Specifically, JATO was able to derive Live Navigations and Speed Limiters from vehicle specification while Autotelex was not. What is noteworthy, is that for Intelligent Speed Adaptation (ISA) both Autotelex as well as JATO were unable to derive this ADAS from vehicle specifications. This is of particular interest since ISA has been the subject of transport policy in recent years.

Figure 2   **ADAS and year of production.**
Percentage of participants' cars equipped with ADAS per year of production. It shows that most ADAS are relatively new. Apart from Cruise Control and Navigation, additional ADAS have only been introduced in cars since 2012, approximately.
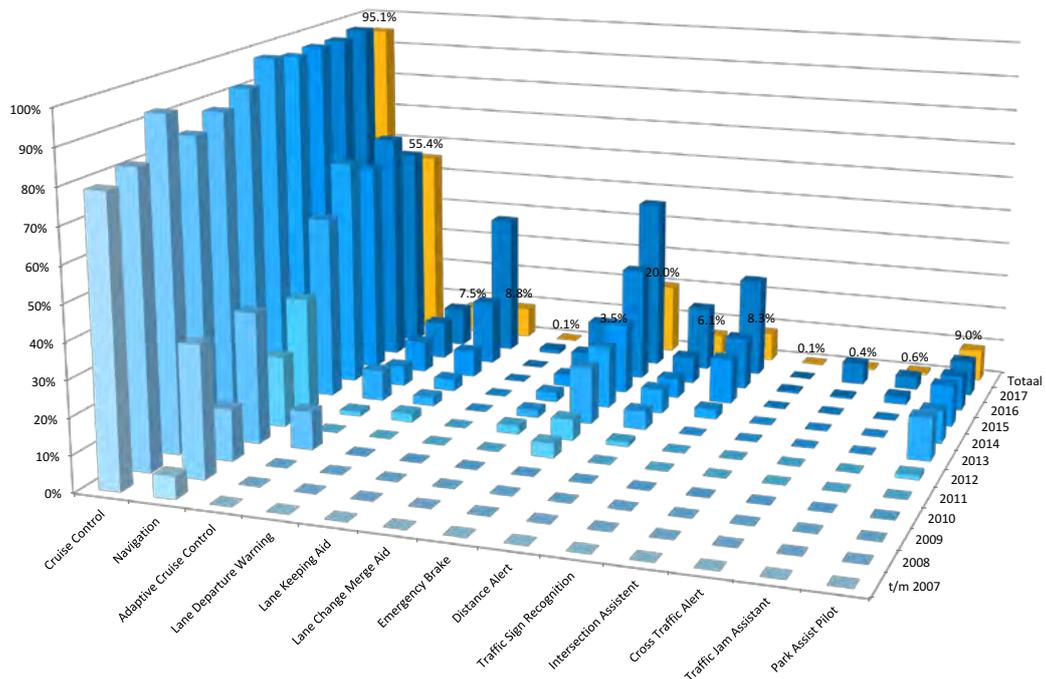
Figure 3　**% Cars equipped with ADAS between 2012-2016.**

Percentage of ADAS-equipped cars, per ADAS:

a comparison between business drivers' cars in the current study and cars in the Dutch fleet as a whole (as derived from RAI[6]). It shows that the business drivers' cars are relatively often equipped with ADAS. The comparison has been limited to cars manufactured between January 2012 and December 2016 as Dutch fleet data before 2012 was unavailable.

* For this ADAS the name and definition used in the current study could not be matched to any of the ADAS described in the RAI-report[6], which were defined by JATO.

** This ADAS could not be derived from the vehicle specifications in the current study, while it was available in the RAI-report[6] through JATO. Note that Intelligent Speed Adaptation (ISA) is not included in as both Autotelex (supplier of vehicle specifications for the current study) as well as JATO were unable to derive this specific ADAS from the vehicle specifications.
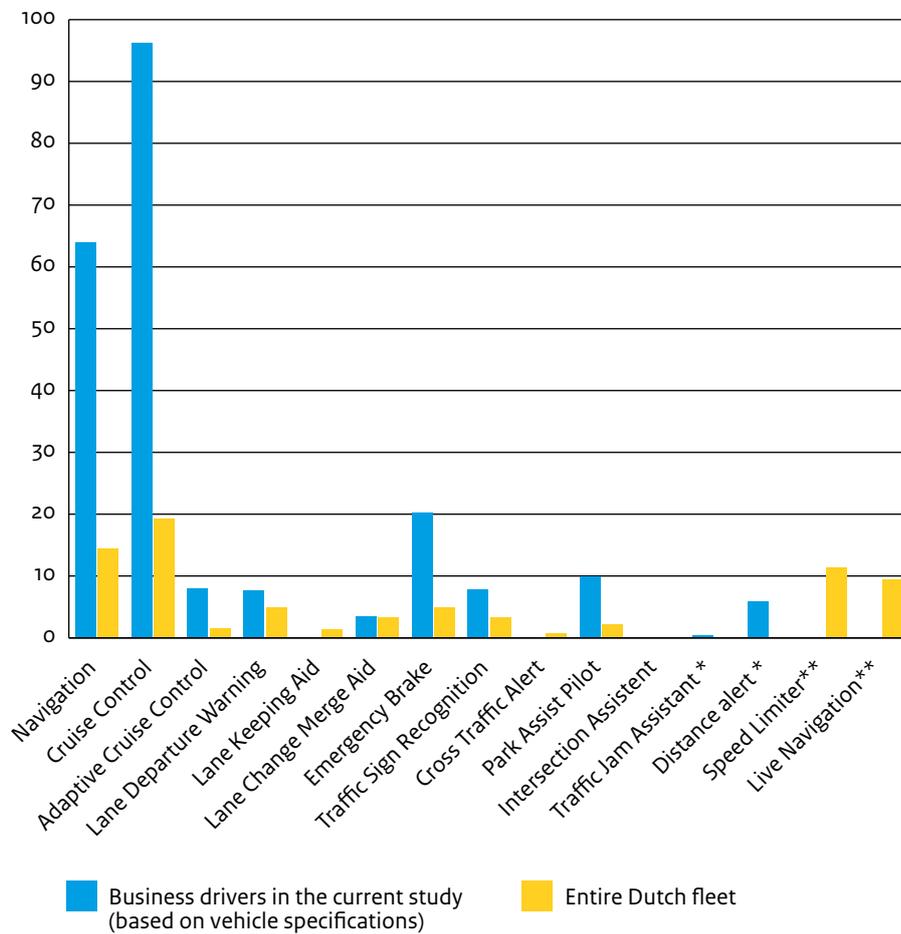
Table 1   **The functionality of all ADAS[c].**

Navigation (without traffic feed)	Gives an automatic route description without up-to-date traffic information
Live Navigation (with traffic feed)[d]	Gives an automatic route description while taking into account up-to-date traffic information
Cruise Control	Maintains your set speed while you are able to release the accelerator. The set speed can only be adjusted by the driver.
Adaptive Cruise Control (ACC)	Maintains your set speed while you are able to release the accelerator and automatically adjusts your speed based on your following distance.
Speed Limiter[d]	Limits the vehicle's speed by preventing it from driving faster than the speed limit manually set by the driver. To drive, the accelerator has to be operate by the driver.
Intelligent Speed Adaptation (ISA)[d]	Automatically limits the vehicle's speed by preventing it from driving faster than the prevailing speed limit, which is set by traffic sign recognition and/or GPS zones. To drive, the accelerator has to be operate by the driver.
Lane Departure Warning	Alerts you when you are drifting out of your lane without using the indicator. The system does not intervene.
Lane Keeping Aid	May alert you and gently steer you back into your lane if you begin to drift out of it without using the indicator.
Lane Change Merge Aid	Warns you for traffic driving in your blind spots when changing lanes. The system does not intervene.
Park Assist Pilot[d]	Recognises a suitable parking spot and parks itself using automatic steering.
Emergency Brake	Intervenes by urgently and automatically applying the brakes in an impending crash with a lead vehicle.
Distance Alert	Informs you about your following distance, but does not intervene.
Traffic Sign Recognition	Shows in-vehicle traffic sign information.
Intersection Assistant	Anticipates traffic ahead of and next to your vehicle, warns you and brakes if necessary.
Cross Traffic Alert	Detects motorised traffic about to enter your backing path.
Traffic Jam Assistant	Automatically keeps your lane in slow-driving traffic. The system does not maintain your speed or following distance.

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[c]   The translation of these ADAS and their functionality in Dutch can be found in Appendix 1.
[d]   As mentioned previously, Speed Limiter, Intelligent Speed Adaptation and Park Assist Pilot could not be included throughout the study. Live Navigation, Speed Limiter and Intelligent Speed Adaptation could not be derived from the vehicle specifications. Being unable to distinguish between regular Navigation (without traffic feed) and Live Navigation (with traffic feed) based on vehicle specifications, results for these two ADAS have been tallied and are referred to as Navigation in the remaining report. Due to a technical error Park Assist Pilot was not part of the questionnaire.

3 The survey

Participants were asked about the sixteen ADAS. They were presented with both the ADAS name as well as a short description of its functionality as described in Table 1. The survey contained questions about whether or not the participants thought that their car is equipped with each type of ADAS and whether they used this particular ADAS on motorways and / or on city roads. Participants who stated that they intentionally do not use a specific ADAS on either one or both road types were asked to motivate their choices. The response categories for this question were derived from an acceptance scale[7] that assesses system acceptance.

"I find it ridiculous you must pay taxes [Dutch: bijtelling] for adding safety systems."

A business driver, Member of VZR

The aim of the second part of the questionnaire is to provide an insight into a user's perspective on ADAS functionality for both their own car as well as ADAS in general. For this, participants were asked how they learned about the functionality of the ADAS with which they thought their car is equipped. Finally, participants matched ADAS definitions and ADAS symbols with ADAS names, in order to obtain a human perspective on the various ADAS. Hence, participants were shown a description of only one of the sixteen ADAS in this study and were prompted to come up with a name that would match the system's functionality. The ADAS descriptions listed in Table 1 were used and descriptions were randomly assigned to the participants, irrespective of the ADAS with which participant's car is equipped. Descriptions were written in Dutch, of which an overview can be found in Appendix 1. Next, participants were shown the symbols of six ADAS and were asked about the functionality they expected from these systems. The symbols used were derived from symbols used by car manufacturers and mycardoeswhat.org.

"CBR allows the candidates since 2016 to use advanced driver assistance systems during the driving test. However, we want to learn more about the interaction between these systems and the driver. The ultimate goal is to create more awareness and skills while using ADAS in order to determine the use of ADAS in relation to the driving test. Therefore stakeholders need to co-operate to develop practical knowledge.""
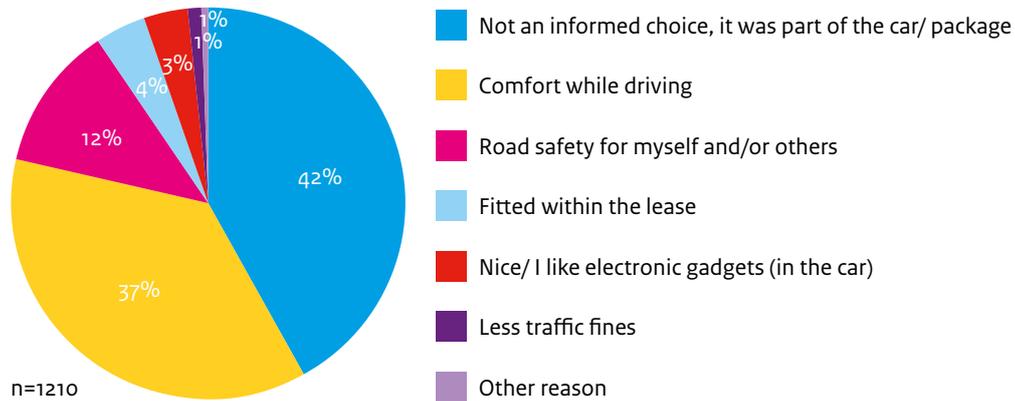
Petra Delsing, MSc. Managing Director, CBR

4 Why their car is equipped with ADAS

Reasons why a car is equipped with ADAS.
An overview of the most important reason why participants' cars have been equipped
with one or more of the ADAS in the current study.

All business drivers, except three, reported that their car has been equipped with at least one of the ADAS in this study. Most of the 1210 participants who answered this question, ticked boxes of three to six of the ADAS in question. In general this concerned a combination of Navigation (with or without traffic feed), Cruise Control, Speed Limiter, Emergency Brake and / or Traffic Sign Recognition.

*ADAS being part of the default option and ADAS added for comfort are
the key factors for explaining why one's car is equipped with ADAS.*

Participants who had reported owning at least one of the ADAS in this study were asked what had been the most important reason that their car is equipped with these ADAS, see Figure 4. For four out of five drivers, this could be explained by either one of two primary reasons. First of all, for 42% of the business drivers the most important reason is that the ADAS were already part of either the car, or the package, of their liking by default. They simply did not consciously choose to have these ADAS on board. Secondly, another 37% stated they explicitly choose the ADAS to make driving easier. Road safety had been the main incentive for fewer participants (12%, 141 participants). For the aforementioned 141 participants, increasing their own road safety, that of other road users, or road safety in general, had been the primary reason to equip their car with ADAS (90%, 4% and 6% of aforementioned participants, respectively).

For only a handful of business drivers the primary reason was that it fitted within the amount they could lease (4%), that they enjoyed having electronic gadgets in their car (4%) or that it reduced the amount of fines (1%). The primary other reason to own an ADAS equipped car is that the employer required it. The three participants who reported not owning any of the ADAS in question stated that this was not an informed choice (n=2) or that the systems were known but not needed (n=1). However, car specifications revealed that in fact two of them possessed cars equipped with Cruise Control.

5 Owning the ADAS and using the ADAS

By combining the results of the questionnaire with the vehicle specifications, it was possible to provide insight into the full chain from ADAS owner to ADAS user. Merely questioning drivers about which ADAS they own is not a good proxy for ADAS ownership; it presumes drivers are already fully aware of which ADAS their cars are equipped with. Awareness of which ADAS your car is equipped with is important, as, for most ADAS, it is a prerequisite for being able to actually use the ADAS on board. Taking vehicle specifications into account enabled insight in this awareness.

"The car industry offers more and more advanced safety and comfort features in modern cars (ADAS). These features provide additional safety for both in-vehicle passengers as fellow road-users. The biggest challenge is, however, not in the technology behind these features, but the purchasing and usage of said features by the end user. This requires a joint effort between representatives of the car industry, retail and end users to enhance the awareness and knowledge."

Steven van Eijck, PhD. Chairman, RAI Association

To make the step from ADAS ownership through ADAS awareness to actual ADAS use, the following ADAS have been looked into: Navigation (with and without traffic feed), Cruise Control, Adaptive Cruise Control (ACC), Lane Departure Warning, Lane Keeping Aid, Lane Change Merge Aid, Emergency Brake, Distance Alert, Traffic Sign Recognition, Intersection Assistant, Cross Traffic Alert and Traffic Jam Assistant. Speed Limiter, Intelligent Speed Adaptation and Park Assist Pilot were excluded from the comparison due to the various constraints mentioned previously. As Lane Keeping Aid, Lane Change Merge Aid, Intersection Assistant, Cross Traffic Alert and Traffic Jam Assistant were owned by just one, forty-seven, just one again, six and eight participants respectively, these features were not included in the comparison either. The results of the comparison for the remaining seven ADAS are shown in Figure 5. Striking is that with four out of these seven ADAS 65% up to 83% of the participants were unaware of actually owning these ADAS. This lack of awareness of ADAS ownership involved Adaptive Cruise Control (ACC), Lane Departure Warning, Emergency Brake and Distance Alert, with respectively 83%, 79%, 65% and 74% unwitting ADAS owners. On the contrary, almost all participants who owned Navigation (with and without traffic feed) or Cruise Control were aware of their ownership (only 2% and 6% were oblivious of this, respectively). For Traffic Sign Recognition, 26% was not aware of owning this ADAS.

The lack of awareness of ownership of ADAS appears the largest bottleneck for their breakthrough.

Figure 5 shows that participants who are aware of owning a system currently also tend to use it. For almost all ADAS in question, being aware of owning a system is a prerequisite for being able to use it, as most of said ADAS need to be activated consciously. Vice versa, unawareness of owning this type of ADAS renders the driver unable to use said features. Therefore, Figure 5, suggests that the lack of awareness of which ADAS one's car is equipped with currently appears to be a main bottleneck for the actual use of said ADAS.

One might wonder how it is possible to own an ADAS despite not knowing it. One of the reasons for this is that various ADAS need to be activated consciously. For example, to use (Adaptive) Cruise Control it needs to be consciously switched on while driving. When one does not switch the system on, one will not
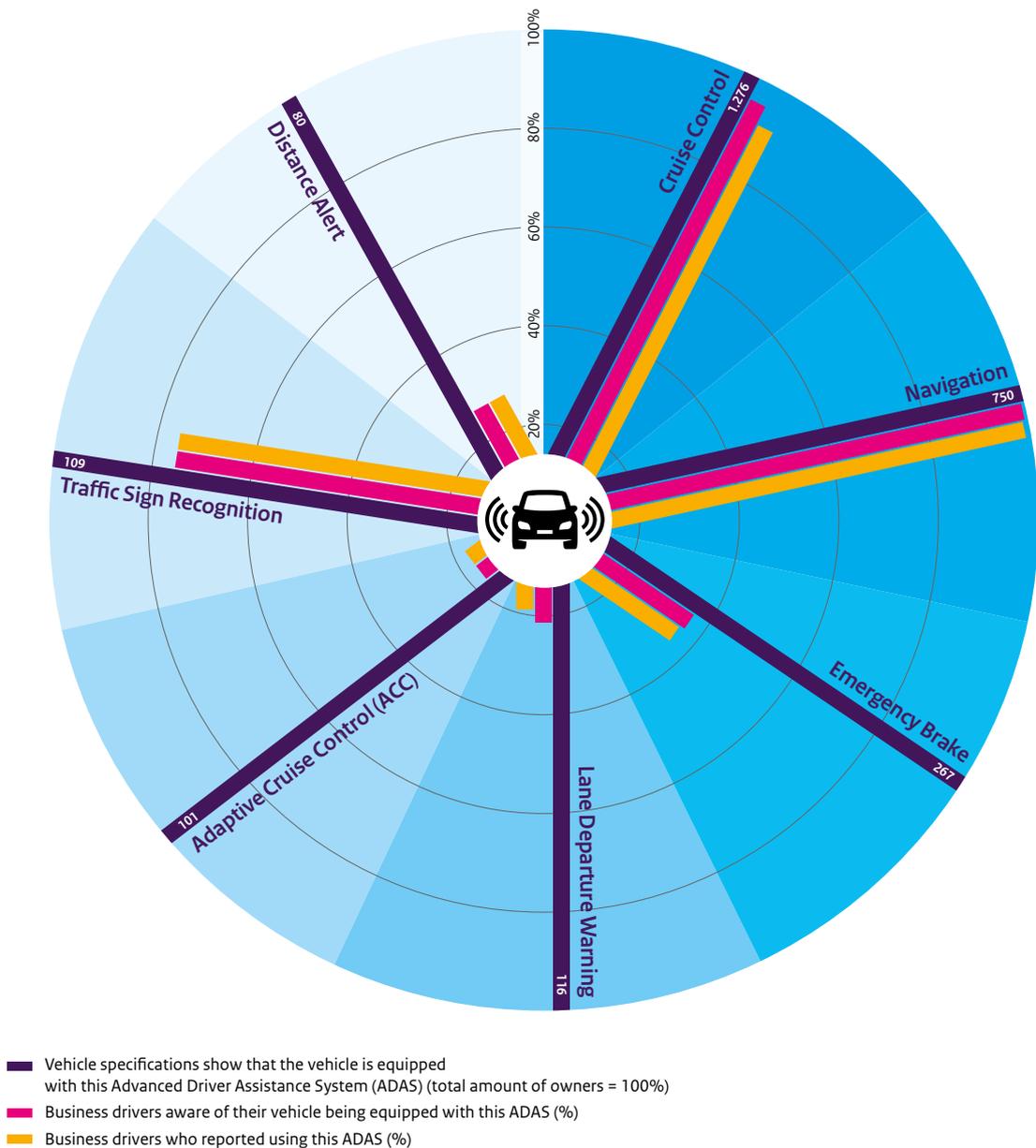
receive any feedback that the car is even equipped with the system in the first place. In addition, there are also ADAS which are switched on continuously while most of the time they do not or barely give any feedback to the car driver at all. These systems will generally only interfere in case of emergency. With this type of ADAS it is possible that one may never notice that the system is switched on as it will only interfere on rare occasions. An example of such a system is Emergency Brake.

"All ADAS work perfectly and I can't do without anymore. My next car will be one with all available ADAS."

A business driver, member of VZR

Figure 5   **Use of Advanced Driver Assistance Systems (ADAS)**.
Awareness and use of various ADAS relative to ownership of said ADAS. Only ADAS with which cars in the current study have been more commonly equipped are depicted.

Vehicle specifications show that the vehicle is equipped with this Advanced Driver Assistance System (ADAS) (total amount of owners = 100%)

Business drivers aware of their vehicle being equipped with this ADAS (%)

Business drivers who reported using this ADAS (%)

Few participants reported never using their ADAS despite wittingly owning them. This concerns Lane Departure Warning (12.5%, n=3), Cruise Control (4.1%, n=49) and Emergence Brake (3.2%, n=3). For this study, we also tried to differentiate between ADAS usage on motorways and on city roads as some ADAS might be considered more suitable for one type of road or another. However, since the amount of participants who reported not using their ADAS on one road type or the other was extremely low for all but one ADAS, it was not possible to report on any meaningful differences for said ADAS. Cruise Control proved to be an exception. From the participants who wittingly own Cruise Control, 50 participants (4.2%) reported never using the feature on motorways compared to 319 participants (26.5%) for city roads. Unsurprisingly, the system not being suitable for this type of road is the most common reason for not using Cruise Control on city roads (53.3%), followed by the urge to be in control (46.4%). The need to be in control is the most commonly mentioned reason to not use Cruise Control on motorways (66.0%). Moreover, this need to be in control appears to be even stronger for motorway driving compared to driving on city roads (see Figure 6). For the other ADAS – except Lane Departure Warning – which are intentionally not being used, the urge to be in control also seems to be the main reason for not using said systems. For Lane Departure Warning on the other hand, the main reason appears to be that it the feature is unpleasant or irritating to use. However, since this concerns only a few participants this result remains inconclusive.

Figure 6   **Reasons not to use Cruise Control.**
Reasons for drivers not to use Cruise Control on motorways and city roads.
Participants were able to provide multiple answers.
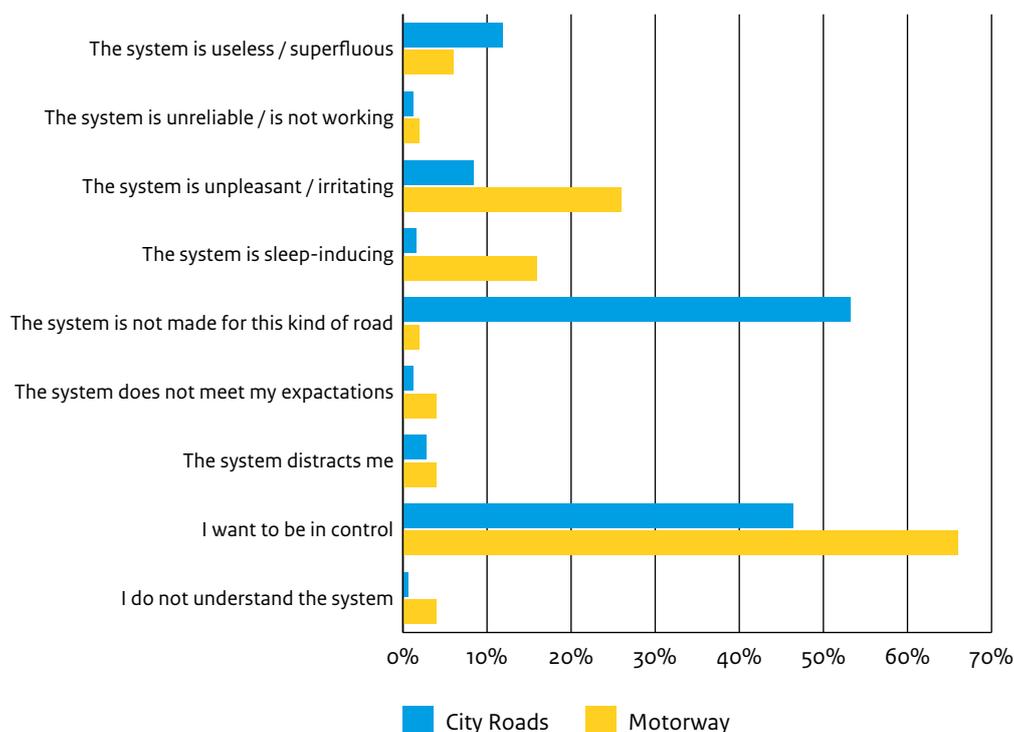
Next to drivers unaware of owning specific ADAS and drivers intentionally not using ADAS they own, the study revealed another group of participants: those who stated owning a specific ADAS while their vehicle specifications contradicts this. According to their vehicle specifications, 4.5% of all 1,355 participants possessed none of the ADAS in question while only one participant (.07%) reported having none of said ADAS at his or her disposal. This is quite a discrepancy. This discrepancy becomes even more pronounced when viewing the results per ADAS. For all cars unequipped with a specific ADAS according to their vehicle specifications, Figure 7 shows – per ADAS – if their drivers think the cars are in fact equipped with said ADAS. Both Cruise Control and Navigation yield the largest difference between vehicle specifications stating the car is unequipped versus the drivers stating that it is, in fact, equipped. There are two explanations which appear most likely to, at least partially, explain for this remarkable difference. Firstly, it may well be possible that the cars in question are in fact actually equipped with said ADAS while the vehicle specifications state otherwise. As vehicle specifications are based on factory fit ADAS, build-in aftermarket devices, nomadic devices and even smartphones (e.g. for navigation) are not included in the vehicles' specifications. The use of these types of devices has become increasingly more common these days. For example, retrofitting systems such as Cruise Control lowers the retail value and hence vehicle taxes. Another example is the introduction of nomadic vision-based ADAS providing warnings for collision prevention and mitigation which have been introduced to the consumer market in recent years. However, given the high percentages of discrepancy it is unlikely that this will explain the discrepancies for all ADAS. It certainly does not explain discrepancies for ADAS of which it is – as yet – impossible to install them in the vehicle aftermarket and for which nomadic substitutes are still lacking. Therefore, secondly, it might also be the case that participants are actually wrongfully thinking they own a specific ADAS whereas in fact they do not. This is not unthinkable, since certain ADAS only provide user feedback on very rare occasions, such as is the case with Emergency Break. Still, wrongfully thinking the car is equipped with ADAS with which it is not, may yield unsafe driving behaviour.

"The Netherlands has been on the forefront of automated driving since the beginning by experimenting and pushing the juridical and scientific boundaries. But we will only benefit (in terms of road safety, traffic flow and emission) when these systems are bought and used by all road users. This research shows that user awareness needs to be increased. That is why, together with ANWB and Connecting Mobility, we will be starting an online 'community' for all drivers who are interested in smart mobility. We invite anyone interested in helping us grow this community, and utilise it to raise awareness and gather and provide knowledge."

Mark Frequin, Director General for Mobility and Transport, Dutch Government
**[In Dutch: Ministerie van Infrastructuur en Waterstaat]**

"Our aim is to stand up for the interests of members of VZR. The personal safety of each driver and the business driver in particular is the highest interest VZR wishes to stand up for. Based on the outcome of the survey it is clear that the safety awareness of the drivers needs to be improved, not only with regard to existing car systems but also whilst ordering the new business car. VZR will take care that this awareness will be enlarged among its members."

Jan van Delft, LL.M. President, VZR (Association of Business Drivers)
[In Dutch: Vereniging Zakelijke Rijders]

Figure 7 **Cars unequipped with specific ADAS according to their vehicle specifications**.
Subdivided by those reporting that their car is in fact equipped with said ADAS, those in the know
that their car is not equipped with said ADAS and those unsure whether or not their car is equipped
with said ADAS whereas their vehicle specifications state it is unequipped.
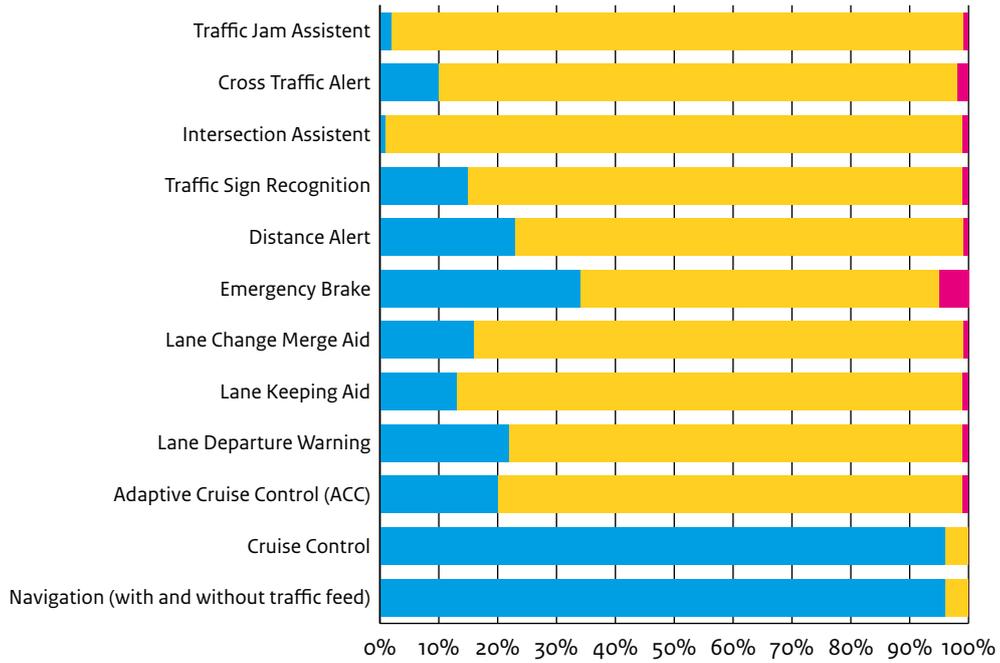

Report their vehicle is equipped with the system, while vehicle specifications contradict this

Report their vehicle is not equipped with the system, in line with while vehicle specifications

Unsure whether their vehicle is equipped with the system,
while vehicle specifications state it is unequipped

6 Learning about your ADAS' functionality

All participants who stated owning at least one of the ADAS in this study were questioned about how they learned about the functionality of the ADAS in their car, see Figure 8. Only 24% reported that they had received instructions at the car dealer on the ADAS with which their car had been equipped. Moreover, reading the brochure or the instruction manual was mentioned more frequently as a source to obtain information on their ADAS' functionality. These sources were used by 36% and 27% respectively. Of the participants, 6% admitted to (also) rely on advertisements to obtain information on functionality. Advertisements, though, are not known for their ability to clearly explain what a specific ADAS can, and cannot, do. However, roughly half of the business drivers (47%) has learned about their ADAS functionality by trial-and-error whilst driving. This showed to be the most common way of learning about the functionality. But, considering participants were able to provide multiple answers, it is possible that on top off learning by trial-and-error, participants also used other sources of information. Therefore learning by trial-and-error is not necessarily totally uninformed. It is also a possibility that participants retrieved information on the various ADAS with which their car is equipped from different sources per ADAS.

Only 24% of the business drivers received an instruction on their ADAS at the car dealer.

Figure 8　**How did they learn how to use their ADAS?**
The various sources participants used to obtain information on the functionality of the ADAS with which their cars are equipped.
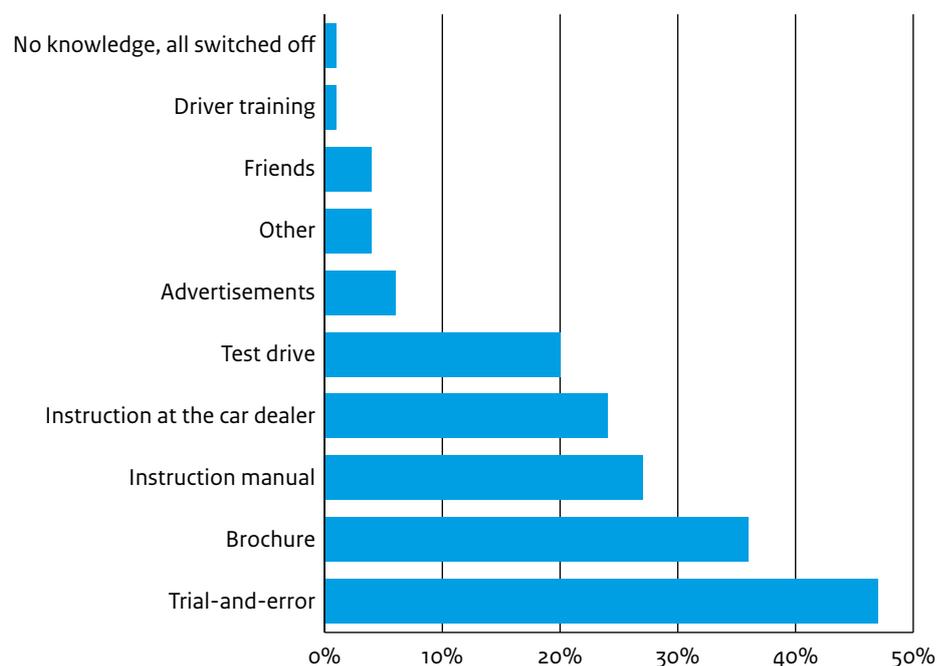
7 What do drivers expect?

In addition to gaining more insight in owning and using ADAS, this study tried to bring a user's perspective to the variety of names given to ADAS. The consumer market for ADAS consists of ADAS with a similar functionality bearing different names and, vice versa, ADAS with similar names while having different functionalities. An example of this is the Traffic Jam Assist, which is also known as Stop & Go. Although the latter sounds really similar to an ADAS named Start-Stop, in terms of functionality the two systems are worlds apart; the latter being a system that automatically shuts down and restarts the engine, whereas the first automatically keeps your lane in slow-driving traffic. Another example of confusing synonyms are Lane Assist (which is another name for Lane Keeping Aid) and Side Assist (the synonym for Lane Change Merge Aid). Although the names are very similar, both systems have a distinctly different functionally. This may lead to confusing the driver. Using one universal name for each system can avoid this. Still, the question remains whether the ADAS name is capable of clearly explaining the systems functionalities. Which functionalities do drivers expect when confronted with a system's name?

In an attempt to answer these questions, participants were shown a description – as shown in Table 1 – of just one of the sixteen ADAS in this study and gave it a name of which they thought it matched the system's functionality. Each description was named by 35 to 60 participants. Since a variety of ADAS names per functionality are in circulation and in absence of a list of standard names, there is no such thing as *the correct name*. Henceforth, the answers should not be regarded as false or correct, but rather as an indication to reveal whether or not a universal term was used by the majority of the participants. The results show that in general this was not the case. Even after clustering the answers for most descriptions, participants gave over fifteen different options. For example, Safety Assist, Anti-Collision Warning, Distance Control, Active Emergency Stop, Protective Brake Assist and Crash Preventer are all amongst the names attributed to the functional description of Emergency Brake. None of these names were preferred by a cluster of participants. Also for the functional description of Adaptive Cruise Control participants came up with a variety of names, including Cruise Follow Mode, Artificial Speed Control, Easy Drive, Automatic Pilot, Cruise & Crash Control, Dynamic Cruise Control, Auto Cruise, Following System, Robotic Driving and Max Cruiser. These were just a few examples of the answers. The only description for which a majority of participants came up with a similar ADAS name was with a the functional description of Cruise Control. Almost 70% (n=31) named this system Cruise Control. A likely explanation for this exception could be that this particular system is more mainstream and widespread compared to other ADAS– it has been widely available for several years and most of participants' cars are equipped with it (95%, see Figure 2) – and the system is not subject to a specific brand name.

"Advanced Driver Assistance Systems have a huge potential to increase road safety. To fully reach this potential it is essential that consumers can trust the systems to work under all circumstances. The automotive industry has to step up their efforts both in design and testing to make sure that the systems work flawless before bringing it to the market."

Frits van Bruggen, MSc. President & CEO, The Royal Dutch Touring Club ANWB

Warning versus intervening systems

For the functionality of ADAS, a clear distinction can be made between systems that only inform or warn the driver and systems that intervene. This distinction can also be recognised in some ADAS names. For example, words such as *adaptive* or *assist*, and derivatives thereof, have been used for systems that can actually intervene in the driving task. Whereas words such as *warning* or *alert* have been associated with systems informing or warning the driver, but are unable to intervene in the driving task itself. Further analysis of the names given by participants to the various functional descriptions revealed that this distinction was not represented in the names given to the various functional descriptions of the ADAS in this study. For example, for the functional description of Lane Keeping Aid – a system that not only warns but also intervenes – 26% of the participants came up with a name reminiscent of a system that can only warn the driver, while only 34% used terminology suggesting the system can also intervene. The remaining 50% did not suggest a distinction between it being either an informative, or warning, system versus an intervening system. To be able to display adequate driving behaviour, drivers need to be fully aware of this distinct difference in ADAS functionality. This is especially important since many drivers learn about the ADAS functionalities of their car through trial-and-error.

"ADAS offers the opportunity to increase road safety by supporting the driver in complex tasks and in hazardous situations. At the same time, one should be careful not to impede people by systems that distract or even annoy them. Using naturalistic driving and simulation research, SWOV investigates how we can maximise the safety benefits of ADAS by combining intuitive support with an eye for the new, supervisory role of those in the driver's seat."

Peter van der Knaap, PhD. Managing Director, SWOV – Institute for Road Safety Research

Language

When allowed to think of a suitable system name, participants displayed a tendency to refer to the ADAS in English, even though the participants are Dutch. For thirteen out of all sixteen ADAS the majority of names were given in English. Only for three systems – which are Traffic Sign Recognition, Lane Change Merge Aid and Navigation – the majority of the answers were Dutch. One possible explanation for this tendency to use English might be that in the preceding questions all system names, apart from Traffic Sign Recognition and Intersection Assistant, were written in Dutch. Another possibility is that the English terms were more familiar in the first place, as car manufacturers also have a tendency to write ADAS names in English.

Resistance against ADAS

Not all participants appeared to be overly excited with the various ADAS. This was reflected in the names they chose for the sytems. For ADAS' descriptions, over 30% of the participants gave the system a name which suggested the system is useless, dangerous or annoying. This involved names such as 'my wife' and 'if-you-can't-do-this-yourself-you-should-not-have-a-license-system'. These types of names suggest a resistance against using these systems. This was especially the case for Traffic Jam Assistance, Intelligent Speed Adaptation, Speed Limiter and Lane Change Merge Aid.

8 From symbol to meaning

As an alternative to using universal ADAS names, a first attempt was made to investigate the possibility of using universal symbols instead. For this, participants were shown symbols for six different ADAS and gave them a name of which they thought it matched the symbol representing the system. Of these 600 entries, between 66% and 82% provided a name for each symbol, which are 494 to 399 participants respectively, with the results being sowhn in Figure 9. Of the participants who answered the question, between 42% to 74% gave the symbol a name corresponding to its intended functionality. This means that the function the symbols represented were generally well understood. An exception to this, however, was the symbol for Adaptive Cruise Control: only 22% appeared to understand this symbol.

Details in symbols

Although the majority of the interpretations of symbols were correct, the remaining answers show that the smallest details of the symbols may cause unintended consequences towards the way the symbol was interpreted. An example of this is the symbol for Traffic Sign Recognition. This symbol contains a 50km/h sign. As a result, 54% of the answers were related to speed, for example Speed Recognition or Intelligent Speed Adaptation. Some participants (2%) even thought that this symbol had something to do with Wi-Fi or communication with traffic signs (due to the similarities with the Wi-Fi symbol).

Warning versus intervening systems

As stated earlier, from a behaviour perspective it is very important that drivers understand the difference between an ADAS that will only inform or warn them versus an ADAS that can intervene in the driving task. The results show that symbols may be suitable to indicate this distinction. When looking into the symbols used for Lane Departure Warning (which informs) versus Lane Keeping Aid (which intervenes), it seems that most participants are capable of correctly interpreting this difference. The symbol for Lane Keeping Aid contains a small steering wheel and 74% of the participants interpreted this symbol as an intervening system, in comparison just 1% of the participants who interpreted this as a system that only warns drivers. Similarly, 72% correctly seemed to interpret the symbol for Lane Departure Warning as being a warning system. However, 24% of the participants seemed to expect the system represented by this symbol actually intervenes by *keeping* the lane.
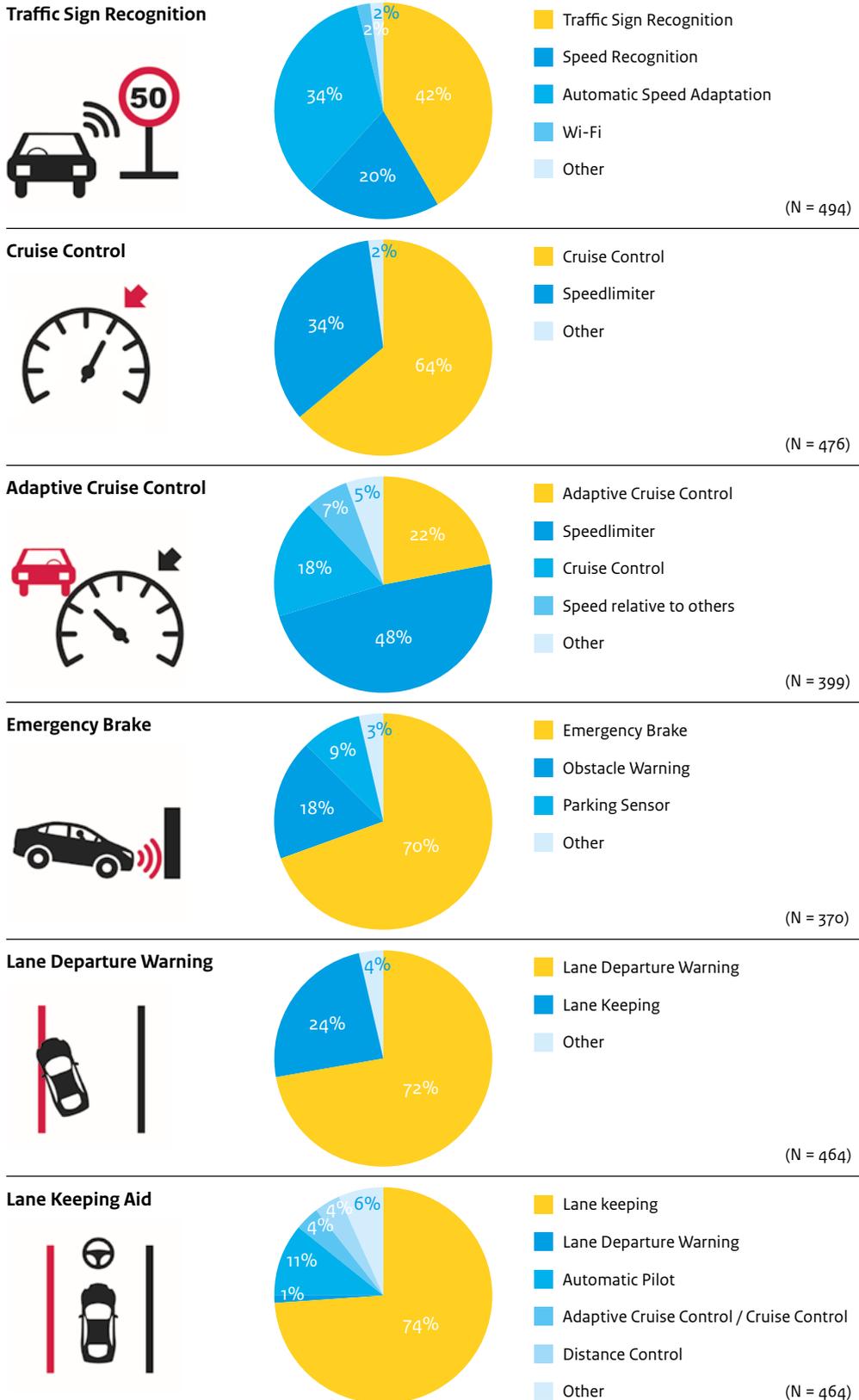
"Vehicle automation will soon evolve to a safety level allowing drivers to take their eyes of the road. However, as evidenced by this study, challenges remain in offering various support and automation options in an intuitive and integrated manner. Icons and simple sounds cannot ensure that users understand functions and system modes. Similar to computers and smartphones we may have to accept that users have limited awareness of the operation of advanced systems, and may have to ensure the safe and acceptable operation of vehicle support and automation irrespectively."

Riender Happee, PhD. Associate Professor, Program Manager Automotive, TU Delft

Figure 9 **Symbols for six ADAS and how participants interpreted them.**
Per ADAS, on the left the ADAS symbol as presented in the survey and on the right the amount of participants interpreting it correctly (in yellow) or incorrectly (in various shades of blue).

Traffic Sign Recognition

- Traffic Sign Recognition — 42%
- Speed Recognition — 20%
- Automatic Speed Adaptation — 34%
- Wi-Fi — 2%
- Other — 2%

(N = 494)

Cruise Control

- Cruise Control — 64%
- Speedlimiter — 34%
- Other — 2%

(N = 476)

Adaptive Cruise Control

- Adaptive Cruise Control — 22%
- Speedlimiter — 48%
- Cruise Control — 18%
- Speed relative to others — 7%
- Other — 5%

(N = 399)

Emergency Brake

- Emergency Brake — 70%
- Obstacle Warning — 18%
- Parking Sensor — 9%
- Other — 3%

(N = 370)

Lane Departure Warning

- Lane Departure Warning — 72%
- Lane Keeping — 24%
- Other — 4%

(N = 464)

Lane Keeping Aid

- Lane keeping — 74%
- Lane Departure Warning — 1%
- Automatic Pilot — 11%
- Adaptive Cruise Control / Cruise Control — 4%
- Distance Control — 4%
- Other — 6%

(N = 464)

9 In conclusion

The main insight for the chain from ADAS owner to ADAS user is that the lack of awareness of ADAS ownership currently appears to be the largest bottleneck for the breakthrough of ADAS usage. The fact that this study has been performed amongst business drivers suggests that these findings may even be more pronounced for the entire Dutch fleet, as business drivers drive more kilometres than others, hence spend more time interacting with their car. Even amongst business drivers, many drivers are not aware with which ADAS their car is equipped. When drivers are aware of owning a specific system they appear to be likely to use it. Even though it is not said that an increase of awareness of ADAS ownership will result in an equal increase in ADAS usage, it is, however, expected that stimulating awareness of ADAS ownership will result in increased ADAS usage.

Stimulating awareness of ADAS ownership may not be as easy as it seems. It is known that the first time, and perhaps currently still even the only time, that drivers are most susceptible for information on their car is around the moment of purchasing a new car. As this time window is rather small, opportunities for actively pushing unbiased information on a car's ADAS and their functionality is limited. This may also explain why only 24% of the business drivers reported receiving information on their car's ADAS through their car dealer. In addition to actively pushing information, new car buyers may also actively search for information, especially those seeking extra comfort through ADAS.The fact that many business drivers (36%) used the car's brochure as a source of information on their ADAS' functionality corroborates this. However, the study also shows that ADAS currently lack a universal description of their functionality. The fact that drivers' interpretations of ADAS names deviate from the functionality intended by the automotive industry underlines that the lack of uniformity in ADAS' names and functionality is indeed a shortcoming. It also makes it more difficult to figure out with which ADAS a car is equipped and what the functionality of said ADAS encompasses. At the moment of writing, to our knowledge, a database easily accessible for consumers to check with which ADAS their car is equipped is non-existent. Understanding the functionality of one's car may also be further improved by increased uniformity in ADAS functionality and self-explaining in-car symbols. This may prove especially useful for drivers who are not in search of information on ADAS in their car, for example those stating the main reason that their car is equipped with ADAS is that said ADAS were part of the default option.

Difficulties for matching ADAS names and definitions arose from the fact that many car brands as well as experts, use a variety of names and definitions. A likely cause for the increasing variety of ADAS names and definitions is that car brands tend to use the names as a unique selling point. Additionally, ADAS are still under development. This means that single functionalities are being combined in new, more integrated systems. An example of this is combining the single functionalities of maintaining speed and recognising traffic signs into a system that automatically adjusts the vehicle's speed based on traffic sign recognition. Hence, functionalities for ADAS change constantly and some systems will even disappear because of merging into another system.

Despite the fact that ADAS are part of an ever evolving industry, it must also be taken into account that these systems have been readily introduced into the consumer market. Consensus or guidelines on ADAS names, symbols, their functionality, and ease of access to this information, will likely improve consumers' understanding of the ADAS with which their car is equipped and what functionality they may expect from these systems.

Acknowledgements

Literature

1   Verkeersveiligheidsmanifest (2017). *Verkeersveiligheid: een nationale prioriteit.* Den Haag.

2   SWOV (2010). *Intelligent Transportsystems (ITS) and road safety.* SWOV Fact sheet, July 2010. SWOV, Leidschendam.

3   Duijm, S., de Kraker, J., Schalkwijk, M., Boekwijt, L., & Zandvliet, R. (2012). PROV 2011. *Periodiek Regionaal Onderzoek Verkeersveiligheid.* Rijkswaterstaat: Delft.

4   Stichting Bovag-Rai Mobiliteit (2016). Mobility in numbers, cars 2016-2017 [In Dutch: Mobiliteit in Cijfers Auto's 2016-2017].

5   Centraal Bureau voor Statistiek (CBS) (2016). Passenger cars are getting older [In Dutch: Personenauto's steeds ouder]. https://www.cbs.nl/nl-nl/nieuws/2016/20/ personenauto-s-steeds-ouder.

6   RAI Association (2017). Analysis of safety and comfort features [in Dutch: Analyse veiligheids- en comfortsystemen]. Amsterdam: RAI Association.

7   Van der Laan, J.D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. Transportation Research - Part C: Emerging Technologies, 5, 1-10.

Appendix I

Dutch translation of Table 1: the functionality of all ADAS

Rijtaakondersteunende opties	Functionaliteit
Navigatie	Geeft een automatische routebeschrijving zonder actuele verkeersinformatie.
Live-navigatie	Geeft een automatische routebeschrijving die rekening houdt met actuele verkeersinformatie.
Cruise Control	Biedt de mogelijkheid om uw snelheid vast te zetten zodat het gaspedaal losgelaten kan worden. De snelheid wordt alleen aangepast door een handeling van de bestuurder.
Adaptive Cruise Control (ACC)	Biedt de mogelijkheid om de snelheid vast te zetten zodat het gaspedaal losgelaten kan worden en past de snelheid van het voertuig automatisch aan ten opzichte van een voorligger.
Speed Limiter	Is een snelheidsbegrenzer. U stelt zelf een maximumrijsnelheid in zodat u niet harder kunt rijden dan de ingestelde snelheid. Om te kunnen rijden dient de bestuurder zelf het gaspedaal te bedienen.
Intelligent Speed Adaptation (ISA)	Is een automatische snelheidsbegrenzer. Door het lezen van verkeersborden en/of via GPS-zones stelt het systeem een maximumrijsnelheid in zodat u niet harder kunt rijden dan de geldende snelheidslimiet. Om te kunnen rijden dient de bestuurder zelf het gaspedaal te bedienen.
Lane Departure Warning	Waarschuwt u wanneer u van uw rijstrook afdwaalt zonder dat u uw richtingaanwijzer heeft gebruikt. Het systeem grijpt niet in.
Lane Keeping Aid	Geeft stuurcorrecties en een waarschuwing wanneer u van uw rijstrook afdwaalt zonder dat u uw richtingaanwijzer heeft gebruikt.
Lane Change Merge Aid	Waarschuwt wanneer verkeer zich in de dode hoek bevindt bij het wisselen van rijstrook, maar grijpt niet in.
Park Assist Pilot	Herkent een geschikte parkeerplek en parkeert zelf in met automatische stuurbeweging.
Emergency Brake	Grijpt in door automatisch stevig te remmen bij een dreigende botsing met een voorligger.
Distance Alert	Informeert u over de afstand tot de voorganger via een waarschuwingsfunctie, maar grijpt niet in.
Verkeersbordenherkenning	Toont informatie van verkeersborden in het voertuig.
Kruispuntassistent	Anticipeert op verkeer voor en naast de auto bij het naderen van een kruispunt, waarschuwt en remt indien nodig.
Cross Traffic Alert	Detecteert gemotoriseerd verkeer tijdens het achteruitrijden.
Traffic Jam Assistant	Blijft automatisch de rijstrook volgen bij filerijden maar houdt geen snelheid en houdt geen afstand tot de voorligger.

Colophon