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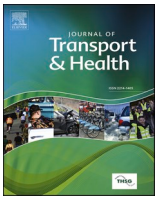

Stakeholder perspectives on the adoption and application of Intelligent Speed Assistance in UK vehicles

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ABSTRACT

Introduction: Intelligent speed assistance (ISA) is an in-vehicle technology which can assist drivers to comply with speed limits and therefore avoid speeding penalties and reduce crash severity and frequency. ISA's road safety impact will depend on the extent to which drivers use it which in turn will be influenced by the actions of stakeholders involved in ISA roll-out.
Methods: This study interviewed 60 stakeholders from road safety practitioners and researchers (n = 14), police and crash investigation (n = 6), insurance (n = 6), driver training (n = 5), manufacturing and technology (n = 12), policy and infrastructure (n = 14) and motoring organisations (n = 3). Thematic analysis generated three superordinate themes: 1) Benefits and concerns, 2) Driver culture and behaviour, and 3) Stakeholder preferences.
Results: Around three quarters of stakeholders were in favour of fitment of ISA in UK vehicles, one third preferred an intervening ISA and one third an advisory ISA. ISA was described as having the potential to reduce road crashes, improve speed compliance, protect vulnerable road users, and change ingrained speeding behaviours. Concerns around ISA included technical inaccuracies, reduced driver control, driver restrictions and system complexity.
Conclusions: Our findings highlight that the potential safety benefits offered by ISA require public acceptance to be realised. Therefore, they indicate a need to develop safety campaigns to highlight these potential benefits.

1. Introduction

Road traffic crashes (RTC) cause approximately 1.3 M global fatalities annually and cost most countries around 3% of Gross Domestic Product (World Health Organisation, 2018). To reduce this burden, the United Nations (UN) General Assembly aim to halve RTC injuries and fatalities by 2030 (UN General Assembly, 2015). In response, the World Health Organisation have adopted a safe systems approach which includes vehicle safety standards, in-vehicle technology, and safe road use (World Health Organisation, 2018). This approach requires input from road safety, network infrastructure, policing and technology stakeholders.

Reducing speed provides an opportunity to improve safety. Speeding increases RTC risk (Aarts and van Schagen, 2006); 25% of UK and 26% of US fatal RTCs involve exceeded speed limits or travelling too fast for conditions (Department for Transport, 2021; National Center for Statistics and Analysis, 2021). Speeding can be deliberate or accidental (Truelove et al., 2022), although research has

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focused on the deliberate aspect which models speeding as a component of driving violations (e.g., Reason, 1990; Rowe et al., 2015). Speeding may be resistant to change because drivers do not perceive it as risky and believe they can make their own rational speeding choices (Elvik, 2010).

Driver assistance systems such as Intelligent Speed Assistance (ISA) have the potential to reduce speeding, and therefore, RTC likelihood and severity. Different ISA types are presently available; advisory ISA provides feedback when the speed limit is exceeded, while intervening ISA automatically slows the vehicle. Various countries have trialled ISA including Sweden (intervening and advisory; Ehrlich et al., 2006), Denmark (advisory; Lahrmann et al., 2012) and UK and Belgium (intervening and advisory; Carsten et al., 2020; Vlassenroot et al., 2007). Intervening ISA has been found to have a larger effect than advisory ISA on speed compliance in field trials (Carsten, 2012; Lai and Carsten, 2012). Lai et al. (2012) estimated that universal adoption of intervening ISA could reduce serious RT injuries by up to 29% compared to 12% with intervening ISA that could be overridden and 3% for advisory ISA. ISA has also been trialled by professional fleets, including Transport for London buses, where it improved speed limit compliance, particularly around 20mph zones, reducing speeding from 14.9-17.8% to 1–3.3% (Greenshields et al., 2016).

Given that ISA can substantially improve road safety, it is important to identify how it can be introduced at national and international levels to maximise its potential. Drivers are a key stakeholder group, in terms of their voluntary adoption of ISA and their acceptance of legislation encouraging ISA provision and usage. ISA was reported as acceptable in a UK field trial (Carsten, 2012); drivers felt positively about using ISA although they also felt disadvantaged compared to drivers without ISA, who could drive faster. Feeling disadvantaged has been highlighted elsewhere (Vlassenroot et al., 2007; Jamson, 2006). Concerns have also been raised about inaccuracies in measuring speed limits and how overtaking might be impacted (Carsten, 2012; Van der Pas et al., 2014). Therefore, options to turn off and override ISA may be important for public acceptability (e.g., Day et al., 2023). The technology acceptance model (TAM) (Davis, 1989) also highlights barriers to ISA use. Stiegemeier et al. (2022) used TAM to relate driver acceptability for in-vehicle technologies to perceptions of system usefulness, complexity, and reduced driver control.

Drivers who have not used ISA previously may be more resistant than experienced drivers. For example, Lahrmann et al. (2012) reported difficulties in recruiting drivers to trial ISA even with financial incentives. Inexperienced drivers may also be more likely to override ISA (Lai and Carsten, 2012). In a sample of UK drivers that largely had not used ISA previously, Rowe et al. (2021) found intentions to override ISA were predicted by separate belief factors addressing (1) safety concerns around using ISA and (2) desire to drive faster and enjoy driving. In a qualitative study, non-ISA drivers expressed concerns around the slowing process, override responsiveness and highlighted lack of knowledge about ISA and low trust regarding accuracy as barriers against acquiring and using ISA (Day et al., 2023).

Previous studies have suggested that drivers may prefer advisory systems because they are less intrusive or restrictive (Jamson, 2006). Van der Pas et al. (2014) also argued that system inaccuracies and driver restrictions are less problematic for advisory ISA. On the other hand, some drivers found advisory ISA less acceptable because they did not like the system indicating to their passengers that they were speeding (Carsten et al., 2020). Advisory ISA uses GPS technology and cameras to detect speed limits and provides warnings to the driver if they exceed the speed limit. Some existing in-vehicle navigation systems may be capable of identifying if drivers are speeding although many do not explicitly inform drivers when they are driving above the speed limit. In contrast, advisory ISA has the advantage that it provides direct warnings to the driver.

Many stakeholders are involved in ISA roll-out. Most prominently these involve government policymakers. For example, the European Union (EU) legislated that new vehicles will have ISA fitted from 2024 (European Transport Safety Council, 2020). The final version of the legislation allowed manufacturers to choose between advisory and intervening ISA. This replaced a draft which would have required overridable, intervening ISA to be fitted, which is likely to have had greater safety benefits. This revision to a less impactful version highlights the importance of understanding the perspectives of stakeholders, especially those involved in developing policy.

While field trials suggest that ISA systems can improve speed compliance and are generally viewed positively (Carsten, 2012; Lai and Carsten, 2012), driver perspective studies on ISA suggest that its acceptability may be related to the ability to turn it off and override it (Day et al., 2023). Concerns also exist around feeling disadvantaged in relation to other drivers, reduced ability to overtake, and speed detection inaccuracies (e.g., Carsten, 2012; Van der Pas et al., 2014). It is important to consider driver perspectives when considering the most effective method of promoting ISA to drivers. For example, Day et al. (2023) highlighted that the personal benefits of ISA should be highlighted rather than focusing solely on safety. However, it is also vital to explore the perspectives of stakeholders who will be involved in the roll-out of ISA. Groups such as government agencies, insurance bodies, manufacturers, road safety experts and police bodies will be instrumental in deciding whether ISA will be mandated in the UK, what kinds of systems will be supported and how these systems will be promoted to drivers. There has been considerable debate in the UK media around these issues (e.g., Horrell, 2022), but no study has yet been conducted which draws these perspectives together to provide insights around the most effective methods of introducing ISA.

To compliment previous work on driver perspectives, the current study explored stakeholder perspectives on ISA adoption by interviewing representatives from a range of UK stakeholder groups, including policy and road infrastructure providers, road safety, the insurance industry, vehicle manufacturing and technology, police, driver training and motoring organisations. Interviews explored perspectives around effective ISA systems, whether and how to introduce ISA, and barriers to ISA adoption. This study aims to develop a wider understanding of the legislative, regulatory, and industry-specific contexts around ISA introduction in the UK. These insights will be important in informing policymakers and industry bodies when selecting the most effective methods for introducing and adopting ISA.

Table 1
Details of participants.

Participant ID	Personal ISA user	Stakeholder Group	Mandatory fitment	Preferred ISA system
S01	No	PI	Yes	Intervening
S02	No (CC)	PC	Yes	Intervening
S03	No	In	Yes	Intervening
S04	No	PI	Yes	Intervening
S05	No (ACC)	RS	Yes	Intervening
S06	Non-driver	RS	Yes	Intervening
S07	Non-driver	RS	Yes	Intervening
S08	No (MSL)	RS	Yes	Advisory initially
S09	Yes	PC	Yes	Intervening
S10	Yes	MT	Yes	Advisory
S11	Non-driver	PI	Yes	Intervening
S12	No (ASS)	RS	Yes	Intervening
S13	No (ASS)	PI	Yes	Intervening
S14	Yes	MT	No	Advisory
S15	No (CC)	PI	Yes	Intervening
S16	No (CC)	RS	Unsure	Unsure
S17	No (ASS)	PI	Yes	Intervening
S18	No	PC	Yes	Intervening
S19	No (ASS)	DT	Yes	Unsure
S20	No (MSL)	DT	Yes	Advisory initially
S21	Yes	MT	Yes	Intervening
S22	No (ASS)	DT	Yes	Advisory
S23	No	PI	Yes	Unsure
S24	No (MSL)	In	Yes	Intervening
S25	No (ASS, CC)	RS	Yes	Intervening
S26	No	In	Yes	Unsure
S27	No	In	Yes	Unsure
S28	No (MSL)	RS	Yes	Advisory
S29	No (MSL)	PI	Yes	Intervening
S30	No	PC	Yes	Unsure
S31	No	DT	Unsure	Intervening
S32	No (ASS)	RS	Yes	Intervening
S33	No	MT	Unsure	Unsure
S34	No	RS	Yes	Intervening
S35	No (ACC)	In	Yes	Intervening
S36	No	RS	Yes	Intervening
S37	No	PI	Yes	Unsure
S38	No	In	Yes	Unsure
S39	No (ASS, MSL)	MT	Yes	Advisory initially
S40	No (ASS, CC)	RS	Yes	Advisory
S41	No	MT	Yes	Intervening
S42	No (ASS, MSL)	PI	Yes	Intervening
S43	Non-driver	MT	Yes	Intervening
S44	No (ACC)	RS	Yes	Intervening
S45	No (ASS)	DT	Yes	Unsure
S46	No	MO	Unsure	Advisory
S47	No	MT	Unsure	Advisory initially
S48	No (ASS)	MT	Yes	Advisory
S49	No (CC)	PC	Yes	Intervening
S50	Yes	PI	Yes	Advisory
S51	No	RS	Unsure	Advisory
S52	Yes	PI	No	Unsure
S53	No	PI	Yes	Advisory
S54	No (ASS, ACC)	MT	Yes	Advisory
S55	No (ASS, MSL)	MT	Yes	Advisory
S56	No	MT	No	Unsure
S57	No (MSL)	MO	No	Advisory
S58	No	PC	Yes	Intervening
S59	No	PI	Yes	Unsure
S60	No (ASS, MSL)	MO	Yes	Advisory

Stakeholder group denoted by RS: Road Safety, PC: Police and Crash Investigation, In: Insurance, DT: Driver Training, MT: Manufacturing and Technology, PI: Policy and Infrastructure, MO: Motoring Organisation. Speed technologies denoted by CC: Cruise Control. ACC: Adaptive Cruise Control. MSL: Manual Speed Limiter, ASS: Advisory Speed System.

2. Method

2.1. Participants

Stakeholders were recruited through mailing members of the UK Parliamentary Advisory Council for Transport Safety, through contacting private organisations including insurers and manufacturers and via participants sharing information with other stakeholders. This achieved a sample of 60 stakeholders from different stakeholder groups (see Table 1). Participants were aged 29–75 years ($M = 51.48$ years, $SD = 10.92$). Study procedures were approved by the Research Ethics Committee of the Department of Psychology, University of Sheffield (reference: 047,810) and pre-registered on the Open Science Framework (https://osf.io/wq2ma/).

2.2. Data collection

Online interviews were conducted July–December 2022 by MRD via Google Meet. Interviews were semi-structured around: (i) understanding of ISA, (ii) potential impact of ISA, (iii) understanding of the regulatory context around ISA, (iv) preferences around fitment and mandating use, (v) system preferences, and (vi) facilitators and barriers to ISA introduction (schedule included in supplementary materials). Interviews were audio-recorded and lasted 26–52 min ($M = 37.68$, $SD = 6.15$). Transcripts were generated

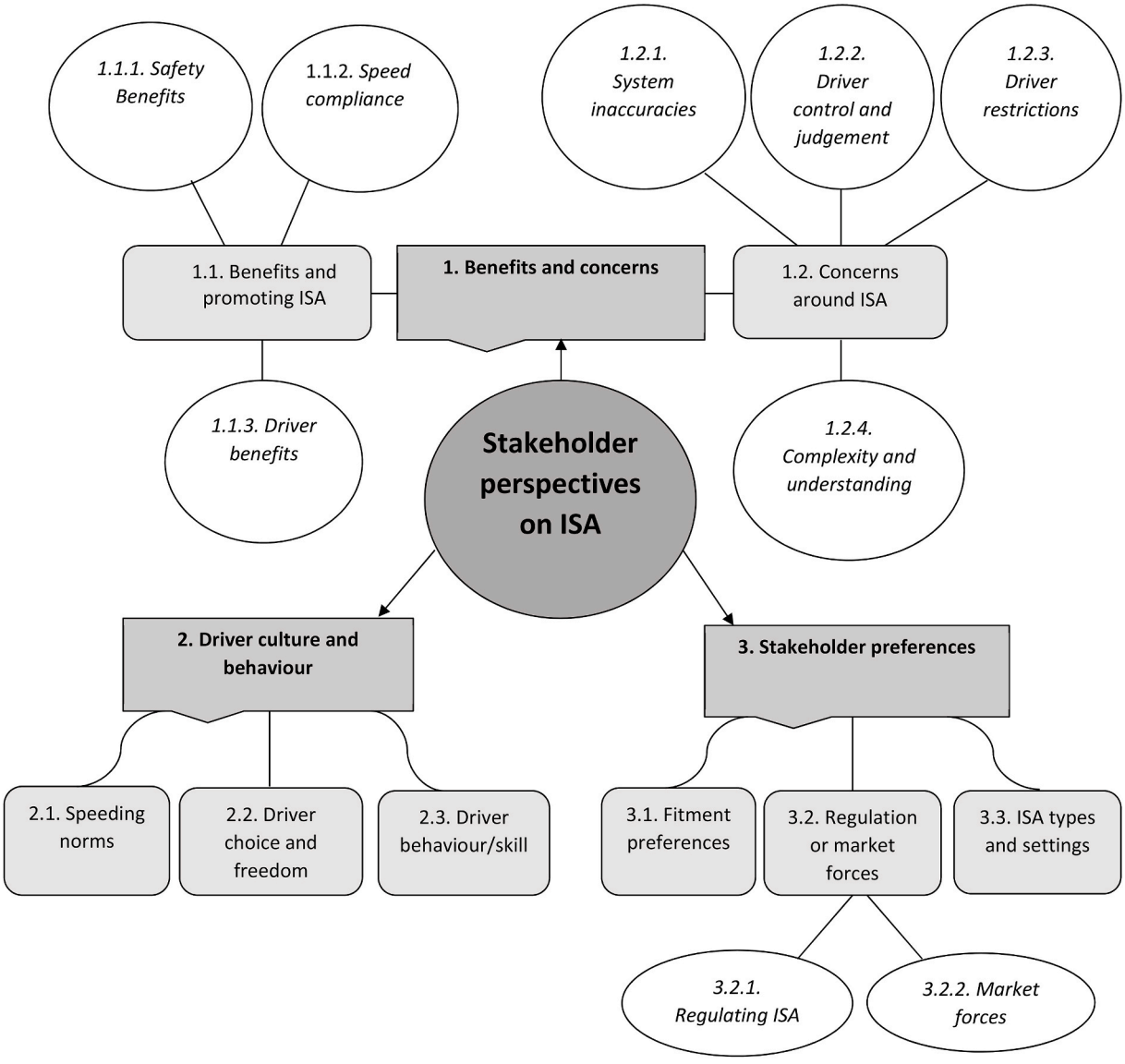

Fig. 1. Thematic map showing superordinate themes (bolded) and subtheme structure.

using otter.ai (https://otter.ai) and manually checked and edited.

2.3. Data analysis

Transcript data was thematically analysed into codes and themes using NVivo 12 (QSR international, 2018). The method followed Joffe (2011) and was used in previous driving behaviour studies (Day et al., 2018, 2023). A realist approach was taken to coding and analysing, in that stakeholder perspectives were taken as representative of their beliefs (Brooks et al., 2015). A hybrid method (Fereday and Muir-Cochrane, 2008), was adopted to generate deductive and inductive codes. Deductive codes were planned prior to the interviews to elicit specific perspectives from the stakeholders. These *a priori* codes included attitudes towards ISA fitment and regulation, and positive and negative evaluations of ISA. Inductive codes were developed from the data during analysis and included codes around driver culture, such as speeding norms and the potential for ISA to elicit behaviour change. This hybrid approach was used to frame the discussion around issues which could be used to evaluate ISA while also allowing unexpected factors to be discussed and analysed.

An initial coding frame was developed from a random selection of 6 transcripts by MRD and then cross-checked by DP to test its consistency, completeness, and validity. Disagreements were resolved through discussion. This coding frame (see Supplementary Materials) provided the template to analyse the remaining transcripts (Brooks et al., 2015). Saturation was achieved once all the data was codable under this coding frame and no new codes were emerging from subsequent transcript coding (Guest et al., 2006). The analytic project files, including coding frames, coding files and thematic structure were discussed and agreed with the research team.

3. Results

The analysis generated three superordinate themes: (1) Benefits and concerns, (2) Driving culture and behaviour, and (3) Stakeholder preferences. Fig. 1 shows the subtheme structure. Quotes from stakeholders are prefixed by their groups (In: Insurance, PI: Policy and road infrastructure providers, PC: Police and crash investigation, RS: Road safety, DT: Driver training, MT: Manufacturing and technology, MO: Motoring organisation). The following determiners illustrate the frequency that beliefs were expressed: a few: >1–14, some: 15–29, many: 30–44, most: ≥45.

3.1. Benefits and concerns

This theme describes stakeholder perspectives on the potential benefits and concerns around ISA roll-out and use.

3.1.1. Benefits and promoting ISA

ISA benefits included improvements in safety, speed compliance and driver benefits (e.g., reduced insurance premiums, reduced likelihood of speeding penalties). Emphasising benefits was seen as important for encouraging ISA fitment and use.

3.1.1.1. Safety benefits. Most stakeholders believed that ISA could reduce crash frequency and severity by reducing speed which would benefit drivers and passengers.

> ISA has that cascade effect, it prevents crashes, it makes the other systems better so the crashes that do happen are at a lower speed (PI:50)

Some stakeholders suggested that ISA could also provide protection for other road users, such as pedestrians and cyclists, which would make ISA most useful in urban environments.

> It's probably more useful in town and built-up area settings, particularly where you have changes in speed limit to … the 20 mile an hour zones and things … that people have difficulty driving at. So I think 20, 30, 40 limits are probably where ISA's most effective and where you are more likely to have vulnerable road users where this system is going to protect them. (In:03)

Some stakeholders thought ISA could slow traffic by impacting the speed of other vehicles which would improve safety more generally.

> If you're actually taking kinetic energy out of the road network, then you will by that very nature, reduce crashes, it will be significant. (RS:25)

Many stakeholders believed that it was important to describe the safety benefits of ISA to drivers, for example, by evidencing the link between speed and risk through crash statistics. However, safety was also thought to be an abstract motivation which lacked personal relevance for many drivers.

> Getting that safety message across is so difficult … We know talking to our behavioural science guys … trying to do the fear, you're going to crash, you're going to die message, that's not going to do anything … it might happen to somebody else, it's not going to happen to me. (PI:37)

3.1.1.2. Speed compliance. Some stakeholders suggested that intervening ISA would increase speed compliance and could be used as

part of speed enforcement. A few stakeholders thought that ISA could be mandated for habitual speeders. However, ISA was usually seen as a tool for generally compliant drivers. Many stakeholders suggested that ISA would stop drivers from speeding through inattention.

> I think when you're looking at this from a policymaking and delivery perspective, you aren't then relying on enforcement as your only tool to control that behaviour. You have an active tool that is in the vehicle so people who want to comply and are generally compliant and law abiding don't have to worry about enforcement of speed as such because they have a tool to support them to do so (PI:59)

3.1.1.3. Driver benefits. Many stakeholders thought that promoting the personal benefits of ISA would be more effective in promoting uptake and use of ISA than focusing on safety alone. Financial benefits were seen as particularly important (e.g., improved fuel economy, preventing speeding penalties, incentivising through insurance) as well as reducing the risk of getting points on their licence (i.e., driver demerit points) and therefore risking losing their driving licence. A few stakeholders also mentioned the potential for ISA to free up attention for other aspects of driving or make driving more relaxing.

3.1.2. Concerns around ISA

Concerns around ISA included inaccuracies in detecting speed limits, reduced driver control, driver restrictions, and system complexity. These concerns would need to be addressed to support ISA roll-out.

3.1.2.1. System inaccuracies. Most stakeholders thought that inaccuracies in detecting speed limits were a significant issue with existing ISA systems, whether due to in-car hardware (e.g., cameras, digital mapping) or poor infrastructure (e.g., sign placement, dirty/old signage). Inaccuracies reduced driver trust and could lead drivers to turn the system off. Inaccuracies were often used as an argument against intervening ISA.

3.1.2.2. Driver control and judgement. Some stakeholders (particularly from the MO and MT groups) had concerns regarding reduced driver control. They thought ISA could be distracting and would not be as efficient at judging safe speeds as the driver would be.

> As a human … like most of our customers, I like to determine when I'm slowing down for the speed limit. I like to be able to assess the conditions of the road. And at the moment, the intelligent speed assistance features don't assess the mood of the driver behind you. They don't assess how far down the road the car ahead of you is. They don't assess really the weather conditions or all of the other factors that make up your decision whether to slow down or speed up (MT:56)

3.1.2.3. Driver restrictions. Some stakeholders (particularly from the MT, MO, In groups) thought that intervening ISA could restrict the driver during manoeuvres (e.g., overtaking and hazard avoidance) which could lead to safety issues.

> If I'm in the middle of trying to do a safe overtake, I'm afraid my view is that that should be done as expeditiously as possible, because it minimises the time exposed to danger. And I don't want a piece of kit coming in and stopping me from briefly if necessary, exceeding the speed limit and then causing a head on … (MO:57)

However, other stakeholders thought that the idea of 'accelerating out of trouble' (DT:45) was a 'myth' (PI:11) that had little relevance to normal driving or was negated by the inclusion of an override.

> It's a really hackneyed argument. And, you know, everybody has always said, what if I need to accelerate out of danger? I've never seen a hazard that I would wish to go into faster rather than slower. Never in all of my life has that ever happened. And I doubt it's ever happened for anybody. But there's this kind of cultural belief that that situation might one day arise, even though I swear it never has for anybody. (PI:42)

Some stakeholders thought there could be concerns around having a mixed fleet of cars (with and without ISA) as ISA drivers could be restricted in comparison to other cars, causing frustration and road rage.

> So if you're bringing this in gradually what you might end up is, in a situation where, for example, you're on a motorway, everyone around you is doing 90, but you're limited to 70, and there are some situations in very high speed environments that I think you can see … you don't want to be going 20 miles an hour slower than everyone else. (PI:11)

3.1.2.4. Complexity and understanding. Many stakeholders thought that a lack of ISA awareness or understanding meant drivers were unlikely to consider it when buying a vehicle, or to try it when it was available. Many stakeholders thought dealerships had a vital role in informing drivers about their car's safety systems, promoting their benefits and providing the opportunity to test drive. However, they felt this was not happening because of time pressures, lack of knowledge from dealers, and lack of interest in safety features.

> In terms of the behaviour side of things, you need to make sure you're getting people to have demonstrations of vehicles and how it's used and maybe even on test drives, to have some sort of demonstration or instruction on how to use it … because if they've not had it at that stage, they're unlikely to use it later. (RS:08)

Rather than relying on car manuals, some stakeholders suggested alternative formats for informing drivers about ISA (e.g., simulators, car-driver interface, informational videos). Trialling was seen as a way of moving from advisory to intervening ISA systems over time. One method of enabling drivers to try out the system was through the increasing use of ISA in fleet and commercial driving.

3.2. Driving culture and behaviour

Norms around speed behaviour were seen as barriers to ISA introduction but also as something which ISA could change.

3.2.1. Speeding norms

Stakeholders referred to three types of speeding behaviour: purposeful, unintentional, and normalised speeding. Some stakeholders believed that ISA would prevent unintentional speeding but would have no impact on purposeful speeding. Therefore, for the generally law-abiding driver, advisory ISA would be enough to encourage speed reduction. However, exceeding speed limits by a small amount or in certain situations was seen as normative and acceptable to most drivers. Some stakeholders thought drivers did not recognise speeding risk because they speed regularly without consequences.

> Until we get to the point where people recognise that speed is a safety risk, and that travelling one or two miles over the speed limit is going to cause problems if everybody does it, then … I just struggle with how people are ever going to engage with such a system (ISA) (MT:10)

However, speeding norms were also seen as a reason for encouraging regulation around ISA or promoting intervening rather than advisory ISA.

> I'm not a great fan of regulation, and particularly putting things in vehicles, but actually, I think, on speed, I think it's been such a difficult nut to crack, because we've got social norms where everybody speeds a bit (PI:15)

3.2.2. Driver choice and freedom

Many stakeholders thought there were barriers to ISA uptake because of a prevailing driver culture which equated driving with individual freedoms.

> It's a sort of mythology that people are quite keen to … I think there's a sort of underlying … set of cultural values around driving, which everyone is susceptible to … about freedom and agency and so on, and people see this as a kind of surrender of that (PI:04)

Some stakeholders talked about the marketing of cars around speed, freedom, and luxury. In this context, ISA could be seen as detrimental to driver experience. However, ISA was seen as a potential tool to help shift towards a more societal view of driving (particularly by the RS, PC and PI groups), through promoting norms around speed compliance, reducing speeding acceptability, and feeding into a general speeding debate.

Some stakeholders highlighted negative impacts of media messaging around driver restrictions on ISA acceptability. Framing discussions around driver assistance and safety benefits was seen to be important to avoid getting into potentially negative debates about driver rights and state control.

> Because I think you only really get one opportunity with a lot of these things. Speeding is such a polarising subject … and it's almost like, we know, it's called intelligent speed assist, what needs to be front and centre is this system is designed to keep you and others as safe as it possibly can. (PC:30)

3.2.3. Driving behaviour/skill

Some stakeholders thought that driving behaviour is resistant to change and saw ISA as more acceptable to younger drivers. Drivers were often seen as overconfident in their driving skills and complacent about their personal risk, which led them to perceive driver assistance as implicitly criticising their driving.

> Because everybody is the best driver in the world. And … as soon as you say … this is going to benefit you for safety, it's almost like a passive criticism of their driving so there's going to be kickback. (DT:31)

Conversely, some stakeholders thought ISA could work as a behavioural intervention to change habitual driving behaviours, through feedback to the driver about their speed.

> I think … the more feedback people get on speed … the less acceptable speeding becomes. (S15)

3.3. Stakeholder preferences around ISA

Stakeholders described preferences for ISA fitment, types (e.g., advisory, intervening) and settings (e.g., override, ability to turn off).

3.3.1. Fitment preferences

Overall, 43 of the 60 stakeholders were in favour of following EU regulations and fitting ISA as standard in UK vehicles. This included almost all from the PI, RS, PC groups and around half of In, MT, DT groups. Only 1 stakeholder (MO) was explicitly against fitment. The 16 remaining stakeholders were unsure or ambivalent, either because they felt the present systems were not accurate enough, more data was needed around effectiveness and public acceptability, or it was better to leave fitment to market forces rather than regulation.

3.3.2. Regulation or market forces

Stakeholders had different views on whether fitment of ISA required regulation or could be left to market forces.

3.3.2.1. Regulating ISA. Around half of the stakeholders thought fitment regulation was required to ensure that all drivers had access to ISA systems with minimum standards.

> I suppose it's probably not the most glamorous feature, is it. All it's doing is restricting you in terms of what you can do with your car. So, I can imagine … that's one of the justifications for regulating it, because it's not something that will, within the natural supply and demand … for the market to enforce it, that's not going to happen. (MT:41)

However, many stakeholders thought there was a lack of political will to regulate ISA, as a result of anti-European sentiment, a libertarian approach to regulation and to avoid unpopular policies.

3.3.2.2. Market forces. Some stakeholders thought market forces would be sufficient for ISA to be fitted in UK vehicles, as a result of regulation from the European market and the EuroNCAP safety ratings which already incentivise ISA fitment.

> it comes in here, whether it's legislated for or not, because they're not going to produce a different engine management system for purely UK when 99%, 95% of the business is mainland Europe (In:35)

However, some stakeholders thought manufacturers were less motivated to fit ISA because of the cost of including an ISA system and their emphasis on vehicle performance and driver experience rather than safety.

> I think that there are obviously those manufacturers who will put this in their vehicles, irrespective of regulation, because … it fits with a brand, it fits with their messaging and what their customers want, I guess for other brands, it's just a cost and a burden to them. (PI:53)

3.3.3. Types of ISA and system settings

Some stakeholders preferred intervening ISA because it would be more effective in improving compliance around speed limits (most of PC, RS groups, half of PI group). They believed that drivers could ignore advisory ISA and that it would have little road safety impact. Some also suggested that drivers found advisory systems annoying. Of the stakeholders who preferred intervening ISA, around half thought it would be necessary to introduce advisory ISA initially, even though intervening ISA would be more effective. These stakeholders thought the intervening system had less public acceptability, and an advisory ISA could begin to build trust and provide evidence for ISA effectiveness.

> Advisory would probably be good in the first instance because it helps to make people more aware and it gives them the option to change their behaviours. Whilst as a road safety professional, I can see the value of a mandatory system, typically, you always have to take these things in steps and move people along gradually. It's very difficult to suddenly introduce something that could completely put people off and actually then not engage with it at all. (RS:08)

Some stakeholders preferred advisory ISA because it would support the majority of compliant drivers without penalising them, maintain driver control, be more affordable and would be necessary because of system inaccuracies (most of MT, DT, In groups, half of PI group). These stakeholders thought that intervening ISA should not be fitted or regulated without more evidence of its effectiveness and reliability.

> In an ideal world, I prefer the latter where you are actually coerced into being safer. However, that completely depends on … the reliability of the speed signal. That's the biggest challenge and you can't intervene unless you absolutely guarantee that the speed information is correct (MT:47)

Many stakeholders thought that being able to turn the ISA system off was necessary for public acceptability and to maintain driver control even though it would reduce effectiveness. Having ISA on by default at each ignition cycle or increasing the number of steps to turn ISA off could increase the likelihood and frequency of using it.

Most stakeholders thought ISA should be overridable, because of system inaccuracies or to retain control over driving. However, the override meant that drivers could ignore ISA and reduced its potential safety benefits.

> I think overridability … is key to its acceptance, but also key to its failings, because drivers will only accept it if they can override it, but the … circumstances in which they determine overriding was appropriate, will be multitudinous, I think. And once you've overridden it once, you've learned that skill, you've learned how to do that, I think the tendency to switch it off will increase. (RS:16)

Some stakeholders thought overriding could be limited in some way so drivers could not continuously speed (e.g., through audible/visual warnings, limits to frequency/duration) or suggested that overriding could be recorded in case of a crash or speeding violation.

4. Discussion

This study explored stakeholder perspectives on ISA introduction in the UK. Most stakeholders believed that ISA could reduce the frequency and severity of RTCs, protect other road users and improve speed compliance. Therefore, the majority favoured ISA fitment although they differed in attitudes towards regulation. Many from the road safety, police and policy groups thought regulation was necessary to ensure drivers' access to ISA while others, including manufacturers, felt market forces would suffice. Road safety professionals usually preferred intervening ISA for its greater effectiveness in reducing road casualties while other stakeholder groups (e.g., manufacturing) tended to prefer advisory ISA to maintain driver control and avoid unpopular driver restrictions.

Some stakeholders thought ISA would prevent unintentional speeding. They considered that advisory ISA would be sufficient to avoid lapses or missed cues around speed and improve speed compliance, as they thought many drivers did not intend to speed. ISA was therefore seen as useful for generally compliant drivers but would not impact on habitual and dangerous speeders. Using ISA to stop purposeful speeding was seen as too restrictive for the majority of drivers. Van der Pas et al. (2014) examined a more restrictive ISA system for speed offenders. While ISA improved speed compliance, it only led to temporary changes in behaviour and was difficult to implement.

Public acceptability was seen as a major issue in ISA introduction. Most stakeholders thought it was important to have public acceptance before fitting ISA as standard or regulating use. Intervening ISA was often seen as less acceptable to drivers, even by those who favoured an intervening system. Half of the group who favoured intervening ISA thought advisory ISA could be introduced initially to improve public trust and support the move towards future intervening systems.

Stakeholders considered low-level speeding to be normalised by most drivers who did not see it as consequential to safety. Therefore, attempts to slow drivers to the limit could be seen as restrictive, especially in relation to keeping up with other traffic. Concerns around feeling disadvantaged relative to other drivers have been raised in field trials (e.g., Carsten, 2012; Day et al., 2023) and so reflect an important perceived barrier to overcome.

Some stakeholders believed ISA had the potential to reduce driver control, distract drivers and lead to de-skilling. ISA was discussed in relation to moving towards automated driving which meant that distrust of automation was reflected in ISA attitudes. Many stakeholders, particularly manufacturers, thought technology was not sufficiently advanced and driver control remained an integral safety system component more generally. This suggests the importance of defining ISA capabilities to avoid concerns around it taking over aspects of driving, to emphasise that the driver retains control and that ISA supplements skilled driving.

Some stakeholders also talked about restrictions related to driver experience. Driving was promoted by manufacturers and motoring enthusiasts via enjoyment and individual freedom and there was difficult media messaging around curtailing these freedoms. Concerns around driver restrictions are likely to be especially significant when drivers do not value ISA safety benefits. Day et al. (2023) found a quarter of drivers stated that speeding was safe in certain situations (e.g., open roads, no hazards, quiet times) and that ISA would feel restrictive in those situations. ISA tended to be seen as a feature which would protect drivers from receiving speeding penalties and so would be less frequently used in areas where this is less likely (e.g., national speed limit roads). Speeding levels and the reasons drivers give for speeding can vary depending on road type. For example, 60% of drivers report exceeding motorway speed limits compared to 46% of drivers on 20mph limit roads, either to keep up with other drivers or because they do not consider the speed limit appropriate (RACRoyal Automobile Club, 2022). Therefore, ISA acceptability might vary based on the roads drivers commonly use.

Drivers have also reported needing to speed for safety in certain situations, such as overtaking and hazard avoidance (Day et al., 2023; Rowe et al., 2021). In the present study, most stakeholders talked about 'speeding out of trouble' with roughly equal numbers supporting and opposing its validity. For both groups, the pervasiveness of the idea was enough to suggest an override option would be necessary for intervening ISA (Day et al., 2023).

As suggested by the TAM model (Davis, 1989) and Steigemeier et al.'s (2022) in-car technology study, perceived usefulness contributes to driver engagement with technology. This was reflected in the stakeholders' views that emphasising personal benefits to drivers would be more effective in promoting ISA than concentrating on safety benefits. This view was also common in drivers (Day et al., 2023). As well as refocusing the perceived usefulness of ISA, emphasising other driver benefits was seen to avoiding difficult debates arising from media focus on driver restrictions.

Some stakeholders suggested that ISA could contribute to behaviour change around habitual low-level speeding, by adding friction into the act of speeding (e.g., through consciously having to turn the system off at each ignition cycle, through the override, or through audio/visual feedback). It was thought that, over time, this could change norms around speed compliance. The potential of ISA to change driver attitudes to speed has also been suggested by Carsten (2012) and Chorlton and Connor (2012).

Most stakeholders identified speed inaccuracies as their main functional concern. This often-fuelled arguments against intervening ISA or supported the inclusion of turn off and override features. In line with the TAM, studies of driver perspectives suggest inaccuracies reduce trust in car technologies and may lead to drivers turning their systems off permanently (Day et al., 2023; Stiegemeier et al., 2022). Stakeholders in the present study emphasised the importance of improving ISA technology, road infrastructure and accurate speed map data to address these issues.

Lack of ISA knowledge was seen as an important barrier to use. Drivers would have less trust in ISA and be less motivated to choose a car with it fitted if they did not understand it. This reflects the importance of perceived usability as highlighted in Steigemeier et al. (2022) and TAM. Present educational methods (i.e., car manuals and explanations at car dealers) were not seen as sufficient by many

stakeholders who thought novel methods may be required to overcome this barrier, including driving simulators and additional input at dealerships.

4.1. Strengths and limitations

A study strength is the number and variety of stakeholders included and their roles in organisations which could influence ISA rollout. The data comes from groups and individuals who were supportive of ISA as well as those who were sceptical or opposed, particularly to intervening ISA systems. Often stakeholder perspectives echoed driver perspectives in previous work (e.g., Day et al., 2023). However, they also highlighted perspectives related to their organisations and industries, extending existing findings.

The sample of 60 was large compared to recommendations for qualitative studies (Dworkin, 2012; Guest et al., 2006) and covered a wide range of stakeholders. However, numbers within each group cannot be assumed to generalise to their industries more widely, particularly where sample sizes were small (e.g., the MO group). The views expressed are likely to reflect personal beliefs as well as reflecting professional views. Moreover, participants had varying experiences of driving and of using ISA and other in-vehicle assistance systems which may have also impacted on their views. Participants were recruited to reflect their professional groups and road safety and/or manufacturing experience and are not therefore representative of the general population (e.g., in terms of age and gender). However, selecting participants from these groups was vital to gain the insights of people who are working in industries relevant for ISA rollout.

Finally, it was noteworthy that the themes brought up by different groups were similar even where the perspectives differed (e.g., around relative ISA benefits and concerns) and were similar to themes in driver studies (Day et al., 2023). This suggests that the terms of debate around ISA generalise across different perspectives.

4.2. Implications of the study

4.2.1. Implications for ISA adoption

The majority of stakeholders are persuaded by the empirical evidence (e.g., Lai et al., 2012) that ISA offers an important opportunity to reduce RTCs. Many stakeholders from a road safety background believed that regulation requiring intervening ISA to be fitted in new cars would be an effective way to introduce it. Stakeholders from other sectors, including manufacturing, were more sensitive to consumer sentiment and therefore preferred advisory ISA installation driven by market forces rather than regulation. Should public acceptance of intervening ISA increase, it may be that these stakeholders would also favour intervening ISA and be more supportive of regulation. For these reasons, developing campaigns to inform the public about the nature and potential benefits of ISA is important. These can (1)address gaps in public understanding of ISA, (2) increase voluntary adoption and usage and (3) increase the perceived legitimacy (McKenna, 2007) of regulation to require ISA fitment. Publicity campaigns can be informed by research addressing driver beliefs regarding ISA (Day et al., 2023; Rowe et al., 2021) which identifies driver concerns and positive beliefs that can be addressed. Our findings suggest that ISA is likely to be seen as most useful by compliant drivers. Therefore, interventions could initially target these drivers before considering challenging subgroups, such as habitual speeders.

Our work also has implications for the format of ISA to be introduced. While intervening ISA was favoured for safety reasons, the option to override was considered important for public acceptability. Our results also highlight that ISA accuracy and reliability is important for driver trust. This will require collaboration between different stakeholders (e.g., road network providers and manufacturers) to ensure speed maps are accurate and speed limit signs are appropriate for ISA systems.

4.2.2. Implications for research

Future research to determine the most effective formats for publicity campaigns and other interventions to encourage ISA usage would be useful. Application of theories of acceptance can suggest intervention strategies. For example, Lee et al. (2022) suggested that positive information, strengthening norms and self-efficacy and reducing perceived safety risks would impact trust and intentions to adopt automated vehicles. Similar approaches may be useful for ISA.

Further exploration of the themes identified here would be valuable as more vehicles become ISA-enabled. Stakeholders suggested that trialling ISA is an important component of encouraging drivers to use it. Therefore, as ISA becomes more common, this might impact the debate around regulation and preferences for advisory or intervening systems. Research addressing specific policy questions on ISA formats would also be helpful. For example, current and future views on the impacts that having ISA systems on by default at the start of each journey would be useful to guide decision-making.

Future work could also examine ISA impacts on different types of speeding. While research has focused on deliberate speeding, growing evidence indicates the importance of inadvertent speeding (e.g., driving ‘on autopilot’: Malhotra et al., 2018; mind-wandering: Smallwood and Schooler, 2006) which could be impacted greatly by ISA.

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CRediT authorship contribution statement

Marianne Day: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Paul Norman:** Writing – review & editing, Methodology, Conceptualization. **Damian Poulter:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization. **Özgün Özkan:** Writing – review & editing. **Richard Rowe:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

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Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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