In with the new? Generational differences shape population technology adoption patterns in the age of self-driving vehicles

Abstract

With rapid growth of self-driving vehicle technologies, policymakers and industry are actively engaging the public to understand attitudes toward smart mobility. As public officials explore implementing connected systems, they may find diverse reactions. We present an important insight using precise technology adoption curves for three age groups within a major initiative in the United Kingdom, going beyond theoretical expectations. Specifically, the adaptation of self-driving cars reflects the patterns of adaptation to previous technologies. Furthermore, older participants were more likely to be late adopters of the technology than younger participants. Implications from these insights offer the opportunity to enhance public engagement and optimize the implementation of such systems, thereby maximizing population benefits.

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“Not so fast” – could be the most appropriate name for initiatives to roll out wide-scale use of automated vehicles, particularly in the United Kingdom. While development of self-driving vehicle (SDV) technologies – and the amenities they offer – accelerates, there remain significant concerns about the public acceptability of any attempts to promote their use. Amongst the most critical of these may simply be generational differences in willingness to use any new technologies, complicated by those who may offer the most resistance being potentially those standing to gain the most by its availability.

The rapid generation of data via a range of smart technologies catalyzes the tempo of developments in intelligent transportation: since 2000, more than 40 projects emerged in Europe to utilize data towards efficient and more convenient transport (Festag, 2014).-Through these data, intelligent transportation systems provide robust and relevant information to plan, coordinate, and manage journeys (Cavoli et al., 2017). Tools range from roadway signage informing drivers of congestion, closures, and arrival times, to adaptive speed control and approaching emergency vehicle warning systems in cars (Ehlers, Ryeng, McCormack, Khan, & Ehlers, 2017).

The prevailing sentiment amongst the automated driving community is that increasing automation of vehicles yields a range of benefits, which are generally categorized as (a) improved safety on the road (e.g. reducing risk of human error), (b) comfort (e.g. elimination of stress associated with finding parking) and increased mobility (for those who need assistance), (c) better economic outcomes (e.g. more efficient motorways and increased productivity), and (d) improved environmental sustainability (e.g. limiting carbon emissions by decreasing traffic congestions). While these classifications have been discussed widely within the industry, we believe this is the first instance where they have been formally disseminated. As presented in Table 1, further potential benefits have also been highlighted in related literature and industrial work linked to the UK Autodrive (UKAD) project, which may also form the backbone of further initiatives that aim to leverage, for example, early adapters to expand diffusion of the technology to those less likely to hold positive views toward SDVs.

[Insert Table 1 here]

In spite of perceived benefits, implementation of SDVs remains a controversial topic for industry and regulators. According to the TCOS framework (Hall & Martin, 2005), to successfully implement a major technology innovation, uncertainties on several levels must be addressed. These include (a) technological, (b) commercial, (c) organizational, and (d) social uncertainty. Contrary to the first three uncertainties in the list, addressing the social uncertainty often requires a piecemeal, human-centered approach to reconcile opposing views and conflicting demands of the various stakeholder groups among the public. A recent survey of travel habits in the UK (Transport Systems Catapult, 2015) identified three domains of transportation improvement that are of relevance to all stakeholders: removing pain points, improving mobility choice, and improving fit with individual lifestyles. The UKAD initiative was thus launched from the view that SDVs might effectively aid in addressing these by engaging industry, policymakers, and the wider public. Its purpose is to bridge SDV technology and the insights drawn from the relevant British population attitudes, ensuring the technology is rolled out in a way that addresses their concerns and desires.

Public Attitudes

As automated technologies continue to be developed and rolled out to meet a number of different economic and environmental policy goals, population attitudes that may determine uptake are critical to assess. Doing so presents a challenge on its own, as public perception is mixed, evolving, and highly contextualized (Clark, Parkhurst, & Ricci, 2016). Age, generational, and gender differences have been identified as key factors influencing the adoption of SDVs. Specifically, males are more likely than females to find value in driverless vehicles (Gifford & Nilsson, 2014; Kyriakidis, Happee, & De Winter, 2015), and younger travelers (Krueger, Rashidi, & Rose, 2016) and those living in large cities (Cavoli et al., 2017; Transport Systems Catapult, 2015) are the most willing to adopt the new technology. These generational differences may resemble the diffusion of innovation curves found in the adoption of other technologies, where early adopters are more likely to be young while the late majority is more likely to be older (Rogers, 2003; Figure 1). These demographic differences suggest that adoption rates could be greatly enhanced by employing communication strategies that account for the characteristics of the given population (Battisti, 2008; Transport Systems Catapult, 2015).

[Insert Figure 1 here]

Expanding the research on population behaviors regarding the adoption of driverless transport is critical (Cavoli et al., 2017). Specific psychological aspects to consider include an undervaluing of change in technological behaviors (Jost, 2015), a fear of using new technologies, and a lack of information provided by intelligent systems (Buscher et al., 2009). These may discourage individuals from trusting and using SDVs (Kõnig & Neumayr, 2017). Other threats include the widespread data collection that is necessary in connected SDVs (Buscher et al., 2009), though many appear willing to share data if it improves travel experience (Transport Systems Catapult, 2015). This is admittedly on the assumption that widespread SDV use will constitute a safe, responsible, and uniformly beneficial public good (Ruggeri et al., 2017), which is a mandate facing industry and municipal officers. Finally, equipping driverless vehicles with autonomous decision-making systems raises ethical challenges and associated moral dilemmas. One of the key moral issues is that individuals prefer autonomous vehicles that protect their passengers at all costs, however, they would like other people to buy vehicles that are programmed to sacrifice passengers for the greater good, such as saving a higher number of pedestrians on the street (Bonnefon et al., 2016).

Technology adoption specifically for SDVs

Research on technology adoption often relies on theoretical curves as opposed to precise breakdowns in fixed contexts. Rather than building on general assumptions, new data must be generated explicitly by and for the population involved with direct reference to the technology in question. This is necessary to address the significant influences an ageing population (Figure 2) may have on the willingness to adopt new technologies, to incorporate relevant contextual factors into interpreting the outcomes, and to use it as a baseline for any future benchmarking or other reference. Better integration of these insights into policies concerning intelligent mobility will likely yield much greater population level participation, particularly if able to leverage segments of the population to encourage others who may receive benefits as presented in Table 1. In turn, this would ideally increase the likelihood of realizing four major aims of such initiatives, that of improved safety on the road, comfort and increased mobility, better economic outcomes and improved environmental sustainability (Transport Systems Catapult, 2015). This piece aims to gain insight into contextual and population factors, which ideally could be leveraged for more effective policy approaches, assuming that technology quality and public demand align as SDV systems further develop.

[Insert Figure 2 here]

Approach

To inform policies that engage the public with industrial advances in SDVs, the UK Autodrive Survey (UKADS) was developed. The 49-item, web-based survey assesses population attitudes toward SDVs along with additional measures about transportation habits, issues faced, and general technology usage. The survey covered a diverse sampling of over 3,000 individuals in the UK. The focus of this piece is on measures regarding age, gender, and technology adoption, with a roughly representative participation across genders, education levels, geographical location, and age groups.

On top of providing their age, all participants were required to respond to an adapted version (Box 1) of the standard technology adoption question (Rogers, 2003). The purpose of modifying the question was not to create a new measure, but to provide discrete categories in standing terminologies that fit the context of SDVs and wider UKADS aims.

[Insert Box 1 here]

Participants were required to be at least 18 years of age to participate. The sample mean (n=2850) was 42.4 years of age with 95% of participants between 22 and 67 and 80.4% between 26 and 64. Young people from 18 to 25 made up 11.5% of the sample; 8.1% were 65 or older. The sample was approximately 55% female but no major gender differences were found, thus such analyses are not discussed here.

Insights

Focusing entirely on data related to technology adoption and age, clear patterns were visible, which includes an overall difference between groups for adaptation; χ^2 (10)=88.33, p<.001. First, the general breakdown across all groups for technology adaptation does reflect the theoretical curve assumed in many studies (Rogers, 2003). In this case (see Figure 3), those who prefer to wait until the price has dropped and those who know others who use the technology comprise the largest group. This pattern holds within and between every age and gender breakdown. As was anticipated, older participants were significantly lower on the technology adoption curve than working age and younger participants (i.e. more likely to resist than to adopt). Likewise, older generations had lower technology adoption, which is also to say older generations are more likely to resist adopting new technologies.

[Insert Figure 3 here]

Further analyses, including multivariate models covering the wider assessments on attitudes, will be published separately. The focus here has been narrowed to emphasize the importance of insights generated regarding age and technology adoption.

Applications for professional practice

While factors affecting technology adoption are not limited to a small number of variables, the clear generational patterns presented are critical for integration in industrial and social initiatives considering SDVs for public goods. It is important to stress the importance of recognizing these as generational matters rather than generalizing to age for two primary reasons. First, within certain age groups (e.g. 26 to 64), there is no clear pattern for such trends to imply a static linear relationship. Second, while the curve is clearly different between the three age groups, and most notably between the youngest and oldest, it does not automatically indicate that increasing age reduces an individual's willingness to adopt a new technology. Instead, it is better understood as an indication that younger generations considered as digital natives exhibit a skew toward innovation and early adoption. Nothing was found within these specific data to suggest individuals actually become less willing to adopt as they age, hence we argue as a matter of generation. These findings are in line with the longstanding and widely cited arguments by Kuhn (1962) that new technological paradigms are more likely to gain acceptance not least because older generations that are more likely to be proponents of a technological status-quo will eventually die.

These arguments exemplify the value of having real data to populate the technology adoption curve rather than simply rely on a theoretically-driven one. Failure to consider how this curve is affected when additional variables are considered would limit the potential for impact of relevant initiatives. Such data-driven policies will go further in generating impact through precise targeting of opportunities and barriers while concurrently being better placed to anticipate prevalence of certain behaviors and preferences across the populations involved.

Additionally, it is important not to over-generalize each of the groups. While lower in proportion, technology avoiders existed in the younger groups and likewise, early adopters were presented in the older groups. Such forms of positive deviance in the latter group will likely produce a meaningful lever in seeking to attract other users of similar ages. Likewise, identifying other likely resisters will assist in engaging individuals that may otherwise not participate in the public good even if they seek to benefit from doing so. Ultimately, these insights should not be seen as negatives, but rather as key factors to consider for optimal delivery of SDVs as a public good.

Such thinking may be critical for ageing populations like the UK to remain competitive in new technologies compared to countries like the United Arab Emirates, where even automated drones are nearing public implementation for transport. Being aware of advances in other locations may also influence local behavior, if public messages demonstrate why such comparisons may matter in terms of staying on technological or economic curves. Furthermore, it must be pointed out that although the insights generated may allow for more effective policies in the UK, these findings may not fully predict outcomes for SDV adoption in other countries.

One additional aspect that policymakers especially will need to consider, is the risk of unintended consequences related to population behaviors where SDVs are rolled out. For example, with younger people being more likely to live in urban areas and thus more able to walk, cycle, or use public transportation, it may be almost redundant to target their involvement in SDVs as a public good. If these groups adopt the technology without attracting others to do the same, then the primary groups of interest have been missed, and SDVs may actually replace otherwise healthy or sustainable behaviors. Whether or not this will be addressed by industry through added features to SDVs or by policymakers seeking to establish social norms remains an open question. These arguments build from the assumption that automated cars – or any new technology – are a public good that assures safety, stability, and health. Realizing this assumption is squarely on the shoulders of industry and policymakers to demonstrate, regulate, and sustain.

Conclusion

Precision from data-driven policies will aid in generating inclusive initiatives: providing benefit for individuals and communities who need them most, while avoiding negative outcomes for those already doing well. These benefits would come through changes in transportation behavior. In this way, not only will impact be possible toward the four pillars (road safety, mobility, productivity, sustainability) of SDVs, but the most critical outcomes for communities and populations – security, stability, and well-being – may also show meaningful gains.

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Theoretical benefits of self-driving vehicles	
Improved road safety	Increased comfort
Better economic outcomes through increased productivity and new market demand	Improved environmental sustainability through reduced travel time and distance
Increased travel efficiency	Reduced congestion
Increased access for elderly and disabled populations	Reduced road volume through increased ridesharing

Table 1. Theorized benefits of self-driving vehicles as a feature of public transportation (adapted from Cohen et al., 2017; Kyriakidis et al., 2015; Transport Systems Catapult, 2015).

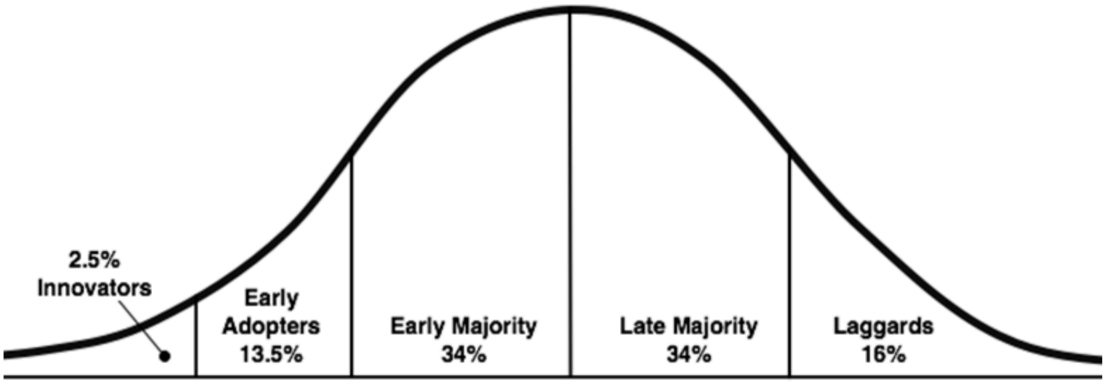

Figure 1. Innovation adoption categorization adopted from Rogers (2003).

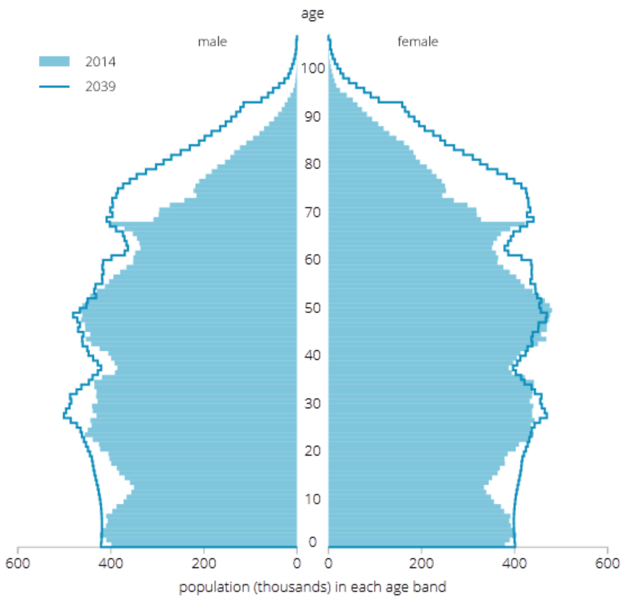

Figure 2. The UK's ageing population (Source: Office for National Statistics, 2015).

Box 1. Item for technology adoption.

If you think about new technology, please select which describes you best.

I am always the first to use new technologies.

I like to use new technologies soon after they are available.

I usually wait for a while (price dropping, more people I know using them) before I use new technologies

I am usually the last person I know to use or own new technologies.

I avoid using or purchasing new technologies unless they are absolutely necessary.

I refuse to use new technologies no matter how popular they become.

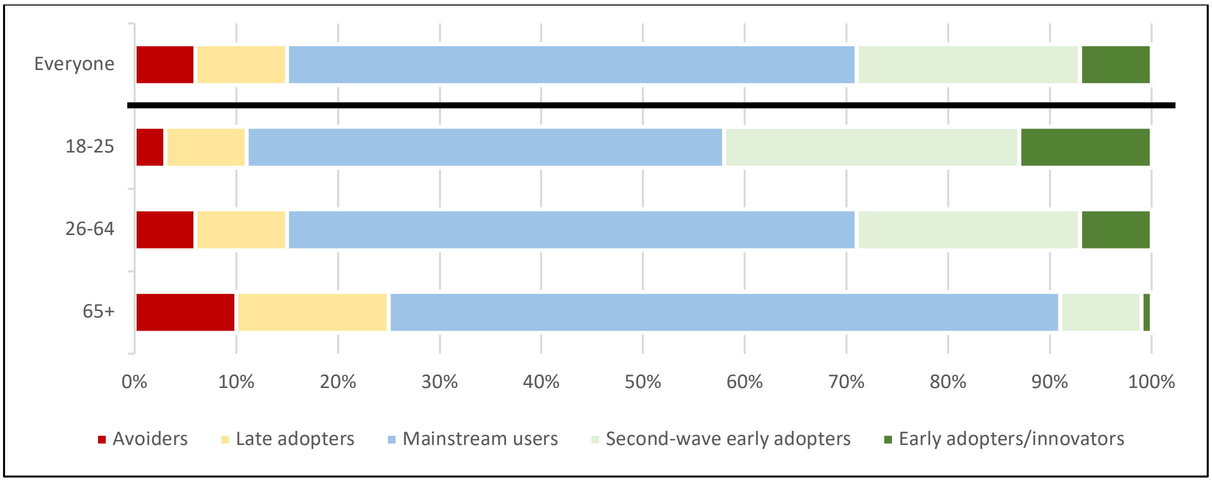

Figure 3. Technology adaptation by generation.