

CONNECTED AND AUTONOMOUS VEHICLES

Revolutionising Mobility in Society





More than 100 years ago the first cars transformed how people travelled. They enhanced our lives, enabling us to go further, faster and in more comfort. This increased mobility has improved the lives of millions of people across the world, with many more aspiring to that mobility as incomes rise.

from travelling see connected and autonomous vehicles as providing hope for the future, opening up journeys and providing tremendous opportunities. The challenge to us as an industry – and to government as well – will be to create the right conditions for this technology to thrive. We need to create the right policy environment, encourage investment and innovation, and, working with other sectors, ensure we maximise the benefits of this life changing technology. ■

Mike Hawes
SMMT Chief Executive

Today, a new generation of vehicles is emerging, vehicles that are connected, increasingly autonomous and which are challenging our assumptions about how they will operate and interact for our benefit in the future. This technological revolution will change how our society functions, improving safety and efficiency, and reducing congestion and emissions. The UK automotive sector is at the forefront of this revolution. In just a short period of time we have witnessed some ground-breaking developments. A number of autonomous driving development projects are taking place across the country and some vehicle manufacturers have begun testing prototype self-driving vehicles on UK roads. Already more than half of new cars sold are available with at least one semi-autonomous driving feature and the vast majority have some form of connected technology. People are already seeing the safety benefits of autonomous driving systems but the transition to the use of fully autonomous vehicles will be a huge step for society and the advantages need to be clearly laid out.

Two years ago research commissioned by SMMT revealed some of the economic and social benefits around connected autonomous vehicles. The numbers were stark. The economic impact of this technology could be worth around £51 billion per year by 2030, with more than 320,000 jobs created, the majority outside automotive manufacturing. Significantly, 25,000 serious accidents could be avoided thanks to technology which reduces driver error.

This report examines how the vehicles of tomorrow will revolutionise mobility for different sectors of society, particularly young, older and disabled people, all of whom could benefit from this transport revolution. Although public and private transportation is changing, many people still face significant challenges in terms of access and mobility on a daily basis. This can hinder their education choices, employment prospects and their ability to access other essential services – freedoms so many of us take for granted.

Connected and autonomous vehicles offer the chance to improve quality of life for many sections of our society. As this report outlines, many of those currently restricted

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There are clear socio-economic benefits that connected and autonomous vehicles (CAVs) can bring to social groups that face significant mobility restrictions. The three groups focused upon in this report (young people, older people and those with a disability) suffer most from restrictions to their personal mobility. Our study revealed that there remains much to be done to improve CAV awareness and dispel current scepticism, as current understanding of the technology is limited to approximately only half of the population. Nevertheless, there is a strong appetite for CAVs among those who have some understanding of the benefits the technology can bring – 56% of survey respondents said they feel positive about the innovation and 43% stated that they would use a CAV if it was made available today. By further creating a positive image of the technology and encouraging its broad acceptance among the public, much stands to be gained from improved quality of life, better employment opportunities and increased access to education.

The three groups focused upon in this report (young people, the elderly and people with disabilities) suffer most from restrictions to their personal mobility. The challenges facing each group are distinct, but all three have identified CAVs as a potential solution, which could not only increase their mobility, but also improve their quality of life.

Over 50%

of all respondents feel their mobility is restricted

Greater mobility could improve access to **education, employment and healthcare**

CAVs could give 1 million UK people better access to higher education

Young people, older people and people with disability have identified CAVs as a potential solution to their mobility issues

48% of respondents said reducing stress of driving is greatest benefit of CAVs

55% were aware of CAV technology but mostly unaware of potential benefits

56% of people surveyed with disability were the most excited about CAVs

KEY SURVEY FINDINGS

The survey results brought to light a number of highly interesting insights relating to current transport provision and preferences, current awareness and opinions of CAVs and perceived challenges and benefits including:

- **The need for CAVs** – Our findings confirmed the need for improved mobility within society. The majority of survey participants agreed that their basic transport needs were largely met, however, more than a third admitted to feeling restricted in some way. This highlights a real need for improved mobility within the UK for large parts of the population.
- **The intricacies of mobility needs** – Each group identified a unique and specific set of transport priorities – there is no “one size fits all” approach.
- **The size of the prize** – A significant benefit of CAVs is the possibility of improving access to tertiary education for more than one million young people.
- **The need for increased awareness of CAVs** – Public awareness and understanding of CAVs must be increased if they are to be successfully deployed in the UK. Just over half (55%) of survey respondents identified themselves as partially or very aware of CAV technology.
- **The current positive perception of CAVs** – The groups we surveyed are ready and excited for the new technologies and the benefits they will bring. More than half of young, older and disabled participants of the survey felt positively about CAVs (56%), with young people with disabilities being the most excited about CAVs.
- **The common perceived benefits of CAVs** – The three groups broadly agreed upon the benefits of CAVs, with a reduction in driving stress consistently identified by almost half of respondents as an expected benefit (48%).
- **The size of the prize** – An important benefit of CAVs is the possibility of improving access to tertiary education for more than one million young people.



CAV POTENTIAL IMPACT & CHALLENGES

Our findings highlighted a number of ways in which CAVs would improve people's quality of life. For all three demographic groups surveyed, freedom to travel spontaneously ranked highly, as well as improving participants' social lives. As well as these impacts, our findings revealed potential economic benefits, for example, one million people in the UK stand to gain from an uplift in earnings due to more accessible higher education through improved mobility.

Despite the clear benefits that CAVs will bring, a number of obstacles to their development and roll-out in the UK remain, including potentially low levels of consumer acceptance, poor connectivity and digital infrastructure and increasing international competition to lead the way in CAVs.

RECOMMENDATIONS

Government has a large role to play in ensuring that the full benefits of CAVs are realised in the UK. There needs to be continued collaboration between government, the automotive industry and adjacent sectors (telecommunications and technology in particular) to pave the way for the deployment of CAVs. This report suggests three main recommendations:

- **Increase public awareness and acceptance of CAVs**
 - Government and industry should run an information campaign which dispels myths and highlights the many benefits that CAVs can bring to society. By expanding people's horizons about the advantages of driverless vehicles through communicating the art of the possible, the likeliness of widespread public acceptance increases.
- **Improve the UK's connectivity and digital infrastructure**
 - Government must also, as a matter of urgency, improve the UK's digital infrastructure. Poor mobile internet coverage is already leading some automotive manufacturers to look to other countries to roll out new connected technologies. A failure to address this will undermine the UK's competitive advantage against other international players and delay the roll-out of CAVs in Britain.
- **Secure and optimise investment in R&D**
 - Finally, government and industry must continue to invest in domestic research, development and testing. If the UK is to remain a frontrunner in the race towards fully driverless vehicles, it must at least match the investment seen in other countries and target investment in the areas where the UK can demonstrate that it is competitive and attracts foreign direct investment. The development of a UK CAV testbed is an important part of doing this. ■



The UK car market continued to grow to record heights in 2016, with new car registrations reaching 2.7 million,¹ a 2.3% increase on the previous year. There are now more than 34 million cars on UK roads,² and it is estimated that some 75% of households have access to a car,³ with around 22 million people using them to commute.⁴ However, around three quarters of the total mileage covered by UK drivers is done so by those between the ages of 30-59, who represent approximately 60% of the population.⁵ This segment of society travels, on average, twice as many miles as younger and older drivers, suggesting that the young and older people are not as mobile.⁶ In addition, people with disabilities have a number of mobility challenges separate to the population as a whole that can result in reduced freedoms.

In recognition of the importance of this technology, car manufacturers are moving quickly to develop new connected and autonomous features, many of which are already penetrating the UK market. These efforts have received support from government: in 2015 it established a £100 million R&D fund, matched by a contribution from the industry, to realise a five-year CAV R&D programme and is investing in a new CAV testbed in the UK.⁷ It is also undertaking legislative reform to remove potential regulatory barriers to the roll-out of CAVs.⁸ In addition, driverless car trials are taking place in Bristol, Greenwich, Coventry and Milton Keynes to test the feasibility of fully autonomous vehicles in urban environments.⁹ Through all of this, government hopes to position the UK as a world leader in CAVs.

The purpose of this report is to assess the extent to which CAVs could help improve mobility for young people, older

people and people with disabilities (representing around 35% of the UK population) while also highlighting potential obstacles to their uptake.¹⁰ The report was commissioned by the Society of Motor Manufacturers and Traders (SMMT) and has been prepared jointly with Strategy®, PwC's strategy consulting arm. The following sources have been used as part of the study



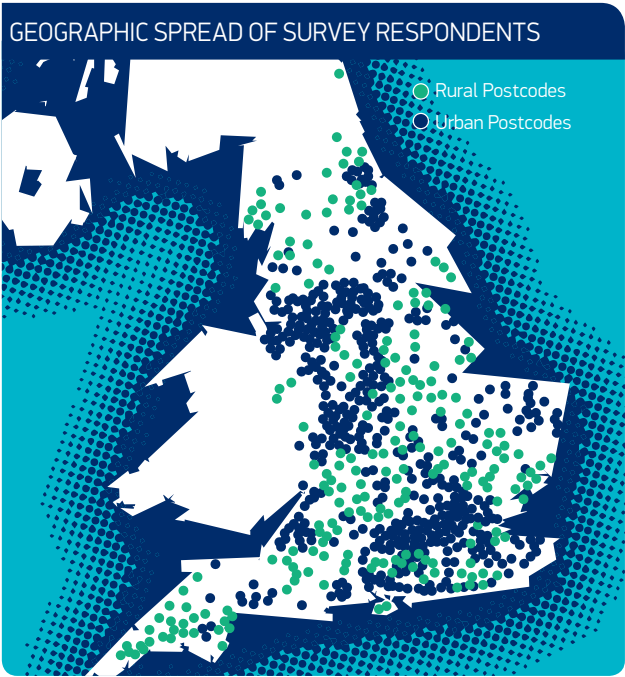
A nationwide survey of more than 3,000 adults in the UK from varying locations (urban and rural), with a minimum of 1,000 respondents in each of the three age demographics (under 25s, those aged 25 to 64, and over 65s). The survey was supported by PwC's in-house Research to Insight team, r2i.



Comprehensive research, drawing on the latest industry perspectives, public policy reports and other material published by the UK government. Strategy® has also leveraged PwC's global network of subject matter specialists and vast repositories of intellectual capital and thought leadership to provide extensive industry expertise.

Survey methodology:

- The survey had N = 3,641 respondents in total
- In order to expand the sample size of people with disabilities, a booster from a specialist disability panel of N = 600 was added to the overall survey population, giving a total of 1,012 disabled respondents



The inability to move freely affects people in a range of different ways, including reduced independence and limits on access to education, employment, healthcare and leisure activities. For some, this results in social exclusion. Three groups are disproportionately impacted by mobility restrictions: people with disabilities and older and young people. Though not mutually exclusive groups, we see distinct issues that affect each of the three.

Based on our survey findings, disabled, older and young people have a number of common needs, preferences and concerns. For instance, all three groups cite the frequency of public transport as a barrier to being able to travel when and where they want. However, the level to which each group is impacted by each mobility constraint varies. For example, 43% of young people selected the cost of public transport as the biggest obstacle to freedom of mobility, exacerbated by the high cost of motoring premiums. However, while cost was a factor for the other two groups, it was not the most frequently selected option. In another example, older people prioritised flexibility when selecting a mode of transport, whereas those with disabilities more frequently cited reliability.

IN THIS SECTION, EACH DEMOGRAPHIC GROUP HAS BEEN INVESTIGATED IN TURN TO HIGHLIGHT THEIR DISTINCT MOBILITY CHALLENGES AND AREAS OF CONCERN.

6.1. PEOPLE WITH DISABILITY

Disabilities are thought to affect around one in five people in the UK.¹¹ More than half of these people experience mobility restrictions, which equates to approximately 11% of the total UK population.¹² The prevalence of disability also rises with age: 42% of adults over the state pension age have a disability compared with 16% of adults of working age.¹³

6.1.1 Education and Employment

Reduced mobility has significant socio-economic consequences for those with disabilities. Critically, it has a significant and negative impact on access to education. According to the Office for Disability Issues, disabled adults are nearly three times as likely as non-disabled adults to lack any formal qualifications, at 30% and 11% respectively.¹⁴ Among the top four reasons attributed to restricted access to education is the lack of available and frequent local transport.¹⁵ Our survey corroborates this, with 36% of disabled respondents citing infrequent public transport as limiting their mobility. With the increasing importance of higher and tertiary qualifications in the job market – it is estimated that 42% of jobs will require degree level education or above by the year 2020 – the provision of equal opportunities in education to those with disabilities is becoming ever more crucial.¹⁶

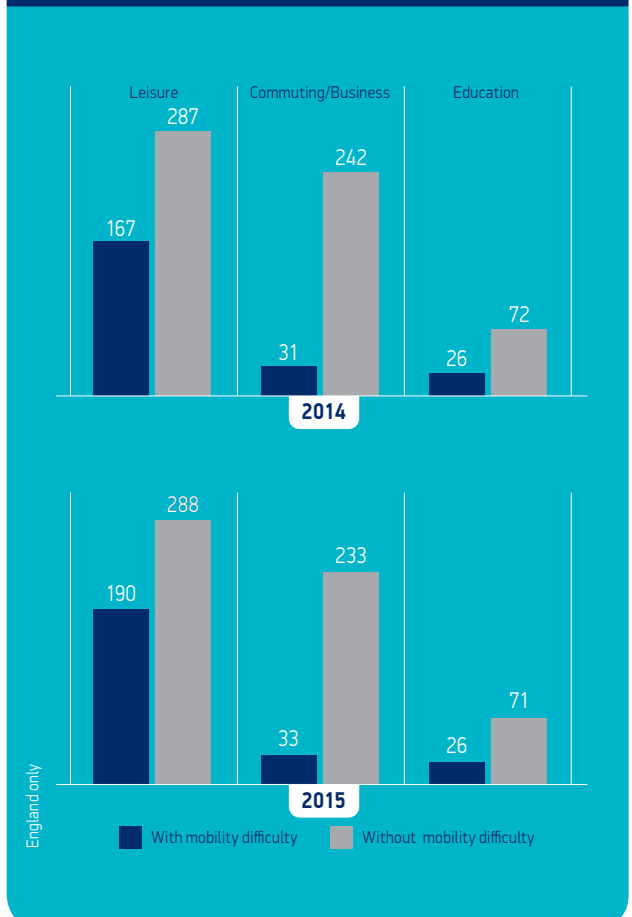
Reduced mobility for people with disabilities in the UK hinders employment. The challenges associated with commuting to work contribute to the fact that only 49% of working-age disabled adults are in paid employment, compared with 82% of those without disabilities.¹⁷ By addressing issues relating to mobility within society, there is the potential to improve access to education, and in turn enable people with disabilities to access well-paid jobs. Such solutions could not only improve people's quality of life but also provide the UK with a substantial economic boost.

6.1.2 Social

People with disabilities have reduced access to social activities. In 2015, people with mobility difficulties made on average 86% fewer commuting or business trips per year than those without difficulties, and 63% fewer trips per year to access education.¹⁸ A similar disparity was observed in 2014.

The impact of reduced mobility on aspects of disabled people's lives presents a strong case to invest heavily in improved mobility within society. CAVs have an important role to play in addressing the deficit that people with disabilities experience in terms of education, employment and social interaction.

TRIPS PER PERSON PER YEAR @ PURPOSE



6.2 OLDER PEOPLE (OVER 65)

Compared with younger generations, older people are considerably more restricted in terms of mobility. For instance, 31% of those aged 70 or over have problems walking or using a bus compared with only 3% of those between the ages of 16 and 49.¹⁹ Furthermore, beyond the age of 65, there is a dramatic fall in the proportion of people with access to a car, with many deeming themselves unfit to drive. Poor eyesight, reduced awareness and longer reaction times are among the reasons why older people do not feel comfortable driving. These difficulties can result in an increased reliance on public transport and assistance from relatives or carers, which can be expensive, inconvenient and stressful, and likely does not inspire confidence to leave the house.

6.2.1 Health

The impact of mobility issues on older people is exacerbated because typically they require increased medical services. Age UK estimates that the average number of GP consultations for those over the age of 75 is more than double the average among all age groups.²⁰ With the 75 and over age group projected to grow by half to 2029, compared with only 8% growth for 30 to 44 year olds,²¹ healthcare and mobility demands of the UK's ageing population are set to increase going forward. This makes addressing the mobility needs of this sector of the population a growing priority. There is some overlap in the needs of the elderly and people with disabilities, nonetheless, the elderly face a number of age-related challenges distinct from those faced by people with specific mobility disabilities. Specific solutions are required to address their unique needs through a wider action programme.

6.3 YOUNG PEOPLE

For the young people in our survey, cost was a dominant mobility constraint. Young people (aged 17-24) face more obstacles that hinder their freedom to travel compared with the rest of the adult population. These include high costs of driving lessons, owning a car and expensive insurance premiums. The total cost of learning to drive alone, for instance, is on average more than £1,200, assuming 45 hours of professional tuition and that the theory and practical tests are passed first time.⁵ Some national schemes exist to aid mobility for the young. For example, the 16-25 Railcard offers a third off rail fares for under 25s. Nevertheless, with public transport often an inadequate substitute, especially in rural areas, this demographic would reap the benefits from a convenient, flexible and cost-effective mobility solution.

In our survey, 29% of young people who do not use a car for transport identified the cost of purchase and high insurance premiums as constraining factors to their freedom of mobility. Furthermore, cost of public transport also inhibited young people's ability to travel freely (43% of respondents cited this

as a factor). As well as being expensive, the findings strongly implied that current service offerings are insufficient, for example, one third of survey participants stated frequency of transport as a restrictive factor, and one fifth cited their living distance from public transport as another.





6.4 LIMITATIONS OF CURRENT MOBILITY SOLUTIONS

6.4.1 Alternative mobility solutions

Advances in technology are now playing a part in expanding the range of mobility options available to today's consumer. The growth of car sharing and ride sharing, through companies such as Uber, Zipcar and BMW's DriveNow, has increased access to transportation and represents an alternative mode of transport that does not have the high fixed costs associated with buying and maintaining a car.

From a consumer perspective, car and ride sharing schemes can be highly attractive in both urban and rural scenarios. These service offerings rely on the network effect to become profitable. In rural settings, however, these services are much more limited or do not operate at all. A significant portion of the UK population living or working outside urban areas is therefore, unable to enjoy the benefits of these types of scheme.

Another limitation of car sharing is cost. On a minute-by-minute basis, car sharing is expensive compared with public transport. Furthermore, many existing car sharing and app-based mobility services poorly cater for people with disabilities, for example wheelchair users. There is a pressing need for improved mobility solutions that provide a good service for a better price. CAVs could be a more affordable mobility solution that offers greater route efficiency and better demand planning, while also helping to minimise traffic congestion. The proportional effect of increased car sharing would offset the short term increase of cars on the road resulting from increased personal mobility for people with disabilities.

6.4.2 Motability scheme

One organisation in particular has been particularly successful in trying to meet the mobility needs of people with disabilities. The Motability Scheme was formed as a partnership between government, banks and manufacturers to promote mobility for these people by providing an affordable, worry-free method of leasing a car.

The influential scheme allows people to exchange their upper rate mobility allowance for the lease of a vehicle, while also arranging insurance, breakdown assistance, servicing and maintenance. Vehicles can be adapted in many tailored ways to suit the driver's specific needs, from hoists that lift wheelchair users into the car to sophisticated driving controls. The scheme has been very successful in increasing the number of disabled drivers on the roads – 2016 saw 68,000 new customers join the scheme, taking the total to 648,000. While the tremendous progress of Motability since its foundation in 1977 is clear, there remains a need for a sustainable, long term solution to improve mobility for disabled adults in the UK. ■

7.1 CONTEXT

In order to evaluate the extent to which CAVs can revolutionise society tomorrow, we carried out in depth analysis to understand what consumers think about them today.

7.2 Key findings of the survey include:

- Cars are the main mode of transportation used by the three groups surveyed
- Young people are the most aware with regards to CAVs, while the disabled are the most excited
- People with disabilities are the most restricted group, with 71% having their ability to travel when and how they want restricted
- 33% of older people are unsure how they feel about CAVs, while they are by far the least aware of this technology
- The most commonly cited potential benefit of CAVs was reduced stress of driving
- 95% of people who believe CAVs will provide a better social life would expect CAVs to enable them to socialise outside of their homes more often.

7.3 Method of transportation and mode of transport selection factors

“Given a choice between 13 factors, 40% of elderly people cited either flexibility or reliability as the most important factor when selecting a mode of transportation”

“A car or van that I own/lease” was the main cited method of transportation by all the three groups. However, their prevalence significantly varied 48% young people, 82% older people, 58% people with a disability. Young people also rated “Bus/minibus/coach” as their main method of transportation. The other groups also chose the option of using “Bus/minibus/coach” as a second method of transportation however, in a much lower scale.

Out of 13 options to choose from when asked about “What factors are most important to you when selecting a mode of transportation” the top five were the same among the three groups. Although the priorities did change within the groups, one key differentiating factor between young and older people was that the former, as shown in other answers, prioritises cost while the second prioritises flexibility when it comes to selecting a mode of transportation. For people with disabilities, answers were tied, with cost and flexibility as two number one factors. The table below demonstrates that.

7.4 Ability to travel restrictions

“71% of people with disabilities have their ability to travel when and how they want restricted”

The group found to be most restricted in their ability to travel when and how they want was found to be people with disabilities. This was not surprising due to the significant number with physical disabilities that impact their movements. The second most restricted group, however, was the young with 65% stating they felt restricted. In this case, a possible explanation may be the underlying cost restriction suffered by the young. In contrast with these two demographic groups, just 36% of older people claimed that their mobility was restricted.

“Frequency of public transport is the main factor restricting older and disabled people, impacting 51% and 36% of older and disabled respondents respectively”

When asked what the obstacles were to freedom of mobility, the primary response related to the frequency of public transport near to where the respondent lives. This was particularly highlighted among older people and those with disabilities (likely exacerbated by pre-existing mobility limitations reducing their ability to reach transport hubs). In comparison, the young once again cited cost as their primary

The range of responses from the three demographic groups illustrates the varying demands of different sectors within society and highlights the complexity of the challenge faced by the industry to meet these needs.

	17-24	65+	With Physical Disability
Cost	28%	13%	17%
Flexibility	10%	26%	17%
Reliability	12%	14%	14%
Speed	13%	13%	12%
Safety	13%	12%	11%
Total % of respondents who cited one of the 5 categories above as first	75%	78%	71%

response, followed by frequency. This finding suggests there is room for improvement in consumer satisfaction with the current provision of public and private transport. This is the opportunity window for CAVs to dominate the market as a more comfortable and efficient solution.

To better understand the broader socio-economic impact of mobility and transportation in the present, somewhat constrained, landscape, the survey also explored aspects of people's lives that were impacted by mobility restrictions. The area of greatest impact was on people's social lives, hindering their ability to meet friends and make new ones, and visit, support and receive support from their families. This was the top factor across all three key groups, but after this, we see a divergence in priorities. For example, young people stating impact on education and work – type and location – as the next most impacted aspect of their life. In contrast, disabled and older people cited access to healthcare, for example, visiting the GP and travelling to hospital, as the second aspect of their life most restricted by public and private transport limitations. This result is in keeping with the identified challenges and concerns relating to health faced by the elderly population in the UK.

7.5 CAV definition provided in the survey

Many vehicles on the road today contain semi-autonomous features. These include features that connect the car to other internal or external features (e.g., social networks) and functions that allow partial or fully autonomous driving (e.g., emergency braking, lane assist technologies). Connected and autonomous features can exist independently of one another but combining the two technologies can be particularly beneficial, particularly in vehicles with higher levels of automation. Autonomous drive settings are enhanced with the increased provision of information that connectivity enables, for instance, providing early warnings of road and traffic conditions ahead.

For the purposes of the survey, respondents were asked to consider CAVs as fully autonomous and connected vehicles; in other words, the cars of the future. Fully automated cars (or driverless vehicles) are designed to fulfil all the driving functions of a regular car, without the need for any human interaction. These vehicles, which can also be driven by a human if required, can operate completely autonomously, navigating roads, stopping at traffic signals and responding to potential hazards such as pedestrians and cyclists. Fully connected and autonomous cars can be programmed to transport themselves to a destination of the owner's choice, allowing passengers to relax in peace or do other things such as take phone calls or enjoy the car's entertainment system. Completely autonomous vehicles are not forecast to emerge in UK production until around 2025, achieving approximately 25% penetration by 2030. However, this study

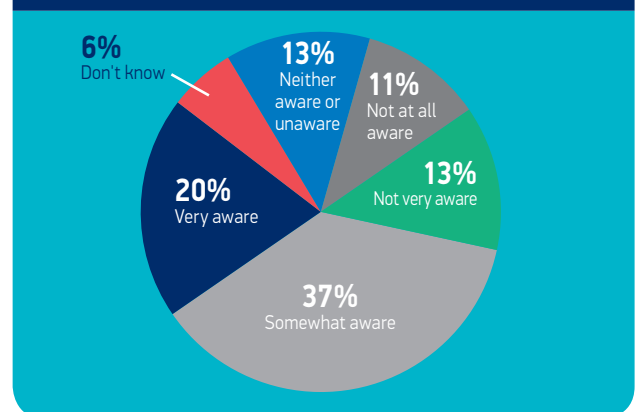
aims to establish how more advanced technology presents an opportunity to revolutionise mobility in society.²⁴

7.6 Consumer awareness and opinion of CAVs

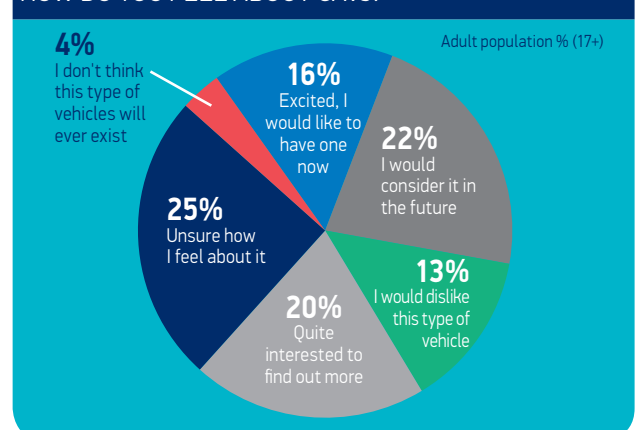
While there is significant value to establishing the potential benefits of CAVs, an equally useful exercise is to establish current levels of awareness and perception of CAVs among the demographic groups being discussed here. 57% of young respondents and 51% of those with a disability stated that they were very or somewhat aware of 'connected and autonomous' technology in vehicles. The survey corroborates that awareness is lower among the older population, with 45% being somewhat aware of CAVs, and only a fraction of the participants (7%) being very aware of the technologies. Approximately one in five claimed no awareness of connected or autonomous vehicles.

More than half of survey participants said they felt positively about CAVs (56%), with young people with disabilities being the group most excited. A likely explanation for this positivity is a combination of this section among society having the greatest mobility needs, as well as the greater acceptance of young people of technology. 75% of these respondents said they trusted technology to some extent or to a great extent.

YOUNG PEOPLE'S AWARENESS OF CONNECTED AND AUTONOMOUS TECHNOLOGY IN VEHICLES



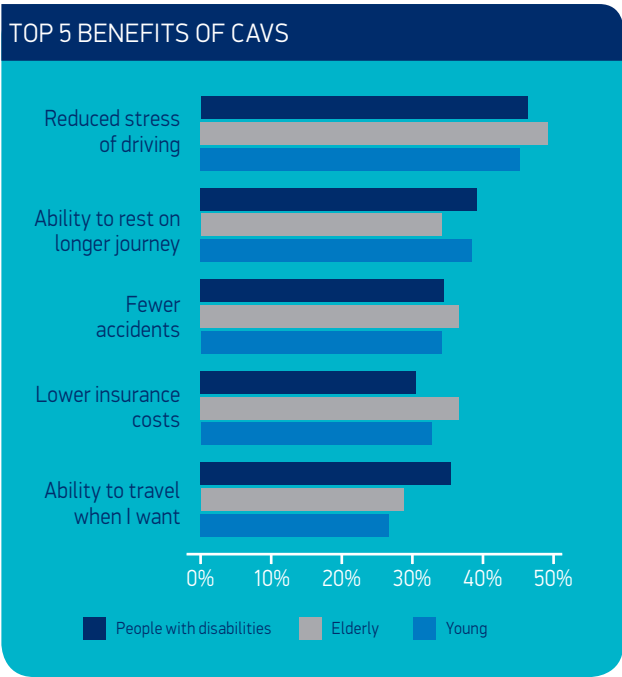
HOW DO YOU FEEL ABOUT CAVs?



7.7 Perceived benefits and quality of life impacts

“Reduced stress of driving is the most commonly cited potential benefit of CAVs”

One of the primary goals of the survey was to establish consumer perception of how CAVs can bring about benefits relating to mobility within society. The highest ranking perceived benefit of a fully connected and autonomous vehicle across all three demographic groups is the resultant reduced stress of driving – 45% of young, 49% of elderly and 46% of people with disabilities consider this to be a core benefit. For adults with disabilities, a third priority is an increased ability to travel using CAVs whenever they want. The proportionally much higher selection of this factor among those with a disability likely relates to their increased reliance on carers for mobility, suggesting that CAVs also have the potential to significantly increase their independence.



All three demographic groups focused upon here corroborate that the most attractive feature of a CAV is automated or assisted braking when approaching a collision hazard, adding to the overall perception that CAVs can significantly reduce driving stress. Parking assistance such as locating nearby available parking spaces closely follows as another attractive feature. These benefits relate to ‘automated’ rather than ‘connected’ aspects of CAVs, which may in part relate to current factors that are prioritised when choosing a car. Safety is the primary concern for UK adults over the age of 25, whereas other features, including entertainment systems and the ability to connect to external networks such as the internet are lowly ranked in terms of priorities. This trend can be most starkly observed among the elderly.

Parking Assistance

Driver fatigue and wellbeing monitoring

Top most attractive CAV feature

Fully automated driving

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The survey identified that people liked the increased freedom provided by CAVs to engage in other activities instead of driving, for example working, reading or resting on longer journeys. However, the connected features we presented such as control of home appliances (eg, lighting and central heating) were considered less attractive. We anticipate that people will increasingly prioritise entertainment and connected features with the growth in CAV uptake and as they become more familiar with the technology.

As well as the benefits to the driving experience and journey itself offered by CAVs, there are broader benefits relating to quality of life. Out of the respondents who stated that having a fully connected and autonomous vehicle would improve their quality of life by enabling them to leave the house more often and improve their social life, 95% would expect to go out at least once more per week.

Lane change assistance

Top 6 attractive features

Automated braking and hazard perception

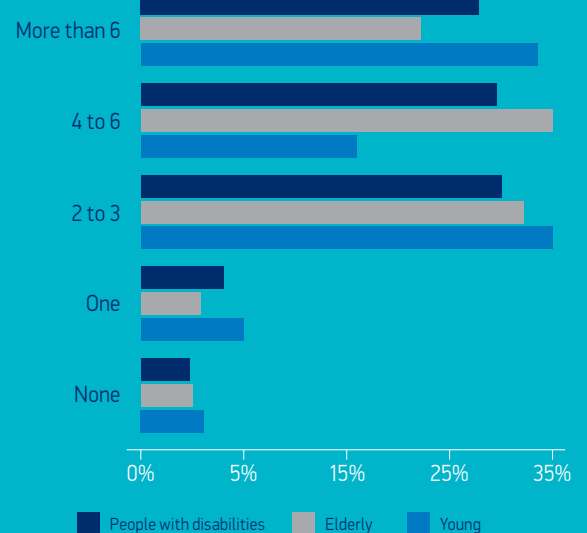
Self-diagnostics and alert & rescue

Loneliness is a growing problem, and it gets progressively worse the older people get. The proportion of older people who feel lonely doubles above age 80, affecting three out of 10 older people.²⁵ CAVs represent a partial solution to address this issue of social isolation and simultaneously combat the associated health risks faced by older people within society.²⁶

When asked about the types of activities that CAVs would allow them to participate in more frequently, responses ranged from fundamental activities such as grocery shopping to pursuing hobbies outside of home, participating in more cultural activities such as concerts, museums and sports games, and eating out more. In this respect, CAVs could increase enjoyment of the lives of the UK population, and represent an opportunity to boost the UK economy by providing growth for social and cultural activities within communities.

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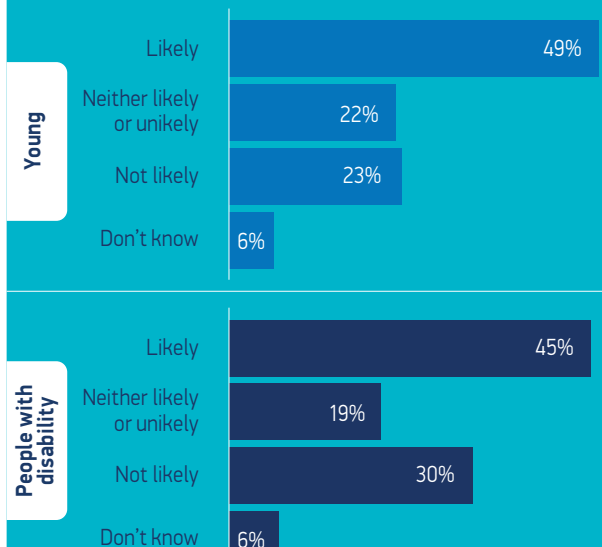
IF YOU HAD ACCESS TO A CONNECTED OR AUTONOMOUS CAR, ON HOW MANY MORE OCCASIONS PER MONTH WOULD YOU EXPECT TO SOCIALISE OUTSIDE YOUR HOME?



7.8 Consumer adoption of CAVs

As previously seen with both awareness and restriction, the responses of the young and disabled demographics broadly matched one another, but contrasted with the responses of older people. Less than a third (28%) of older people claimed that they were likely to use a CAV today, versus 49% of young people.

IF A CONNECTED AND AUTONOMOUS CAR WAS MADE AVAILABLE TO YOU TODAY, HOW LIKELY OR UNLIKELY WOULD YOU BE TO USE IT?



Freedom to go when I want and where I want...

[to see] younger members of my family ... it would make me more mobile although not in the walking sense.

The idea of an autonomous [car] has me feeling excited and glad to be alive.

I would consider myself a more mobile person in that

I could go places where I am very limited just now.

Touring the country would excite me again.

Being able to go to a supermarket of choice and bring my food home, rather than to use a taxi.

Freedom to travel anywhere at any time!

The impact it would have on my life would be huge.

The world would literally open up to me.

A lot of my friends and family don't drive

– even when they visit I collect them from the train station.

last year I was particularly ill and only saw my 6 year old granddaughter once.

I hope I live long enough to enjoy the freedom a vehicle of this type would give.

[It would] make commuting easier

as traffic would have a more autonomous flow with

cars rerouting to ease congestion.

My family live 2 hours up the motorway from me, if I had one of these vehicles I would see them more often.

I wouldn't have to worry if I was ill or tired.

I could go there and back in one day.

The facility to be more time efficient.

Both in the length of time it could take and in the distance I would be able to travel.

Being able to do something else other than driving, if it would still be called that!

Being able to carry shopping for me and for some of my disabled friends.

Enjoy a day out with my friends!

I would be more likely to take a long journey

such as visiting family at the other end of the country, my husband and I could relax and watch films!

However, I could only relax if I knew the cars were safe.

It would reduce my stress levels a lot when driving.

I will feel more comfortable in taking longer trips out...

[It will] reduce my dependency on other people to give me lifts to places further away.

[I would] do longer journeys more often to visit friends and family who live further away.

I'd also be inclined to travel more across the UK

to visit different tourist attractions, doing more day trips and breaks away.

I could go out and get home again legally and safely no matter what.

The worry over the side effects of new medication – gone, the worry whether that glass of wine put me over the limit – gone.

It is like having a permanent taxi.

The possibility of travelling whenever and wherever an individual wants, without the need to drive, brings a new degree of freedom that current transport service offerings are not able to provide. With increased mobility comes improved quality of life through, for example, better access to education and jobs. Furthermore, in addition to the enormous potential social benefits of CAVs, there are also significant economic advantages.

8.1 Education and employment

The correlation between education and potential future earnings is firmly established. On average, the higher the level of education received by an individual, the higher the salary that person can expect to earn. The table below illustrates the median pay gap between individuals with varying levels of education. The incremental increases in hourly pay from those with 'no qualifications' through to those with 'higher education' are gradual and relatively small. There is a step change in remuneration, however, between A-levels and attaining a degree. Furthermore, people who do not have a degree are twice as likely to be unemployed 10 years after leaving higher education.²⁷ Increasing access to education, in particular higher education and beyond, is key to increasing earning potential.

CAVs can help over one million people in the UK pursue a university degree

By combining survey insights with the possible uplift in earning potential of prolonged education, we can begin to understand the potential economic impact of CAVs. The survey reveals that 11% of young people and 8% of 25 to 64 year-olds believe that CAVs would improve their quality of life by providing them with greater education choices. In a subsequent question, those who responded positively then specified the level of education that CAVs would enable

them greater access to: GCSEs, A-Levels, undergraduate university degree, post-graduate degree or vocational training. Taking degree level data as an example, we can then explore the potential economic benefit of CAVs in society. Based on the extrapolation of our survey findings to the overall population of the UK, CAVs can help more than one million people in the UK pursue a university degree.

As is evident from figure 14, a degree generally leads to a higher salary. For those who graduate from English universities, their median earnings after 10 years vary significantly compared to those who do not attend university. Male and female graduates earn £30,000 and £27,000 respectively, whereas non-graduates of the same age have earnings of £22,000 and £18,000.²⁹ Using our survey findings and applying this pay differential to the UK population (taking into account the gender distribution in the UK), we see that more than one million people could increase their average salary 10 years after finishing education by £8,509 per annum. In turn, these incremental earnings could improve the individual's quality of life, and boost their self-esteem.

“Whilst the young would expect CAVs to allow them to have more enjoyable jobs, people with disabilities believe that CAVs can actually enable them to get a job”

15% of young survey respondents agreed that CAVs will provide greater employment choices. This is not surprising given their responses relating to the cost of travel, the fact that they are the demographic group owning the fewest cars, and that 65% of them consider their ability to travel to be restricted. This suggests that there is public perception that improved mobility will improve access to the job market.

The impact of higher education on earnings, shown as a percentage pay gap to employees with GCSEs or equivalent level of education²⁸

	Median hourly pay	Pay gap to GCSE	Pay increase compared with previous level
Degree	£16.10	85%	22%
Higher education	£12.60	45%	21%
A-Levels	£10	15%	13%
GCSE grades A*-C	£8.68	0%	7%
Other qualifications	£8.07	-7%	14%
No qualification	£6.93	-20%	n/a



Meanwhile, 11% of people with disabilities said CAVs would improve their quality of life by providing greater employment choices. Unsurprisingly, just 1.8% of older people believed that CAVs could improve their lives by providing greater employment choices. Having access to the job market was not a key concern to this group, since 90% of elderly survey respondents were either retired or unable to work due to sickness or disability.

Those who responded positively to CAVs improving their quality of life by providing them with employment choices, identified four main opportunities: gaining employment, obtaining a job that is more enjoyable, better matched

to their skillset, or better paid. Nearly a third of disabled respondents believed it would help them to get a job. Furthermore, 49% of young people believed that they could get a more enjoyable job.

People with disabilities attribute mobility restriction to various factors. However, the young consistently cite cost as their key issue. If these restrictions are addressed, there is huge potential to provide better employment opportunities for these two groups. We suggest that addressing mobility constraints can boost employment opportunities and upskill the UK workforce. ■

There are a number of hurdles to rolling out CAVs in the UK. This section explores the overarching challenges relating to the acceptance of CAVs, current technology constraints, and the need for the automotive industry to adapt to the changing mobility landscape.

Key challenges to adoption:

- 1. Consumer Behaviour
- 2. Connectivity Infrastructure
- 3. Business Model

9.1 Consumer Behaviour: Influence, acceptance, trust

Consumer acceptance is critical for the effective deployment of CAVs. While difficult to predict, consumer behaviour will be central in shaping the landscape of future mobility. It is vital to get consumer buy-in and build trust along the journey from low-level autonomous features to fully driverless vehicles. With CAVs, the role of the driver is revolutionised, and current drivers must be made to feel comfortable and safe relinquishing control to machines. The Driver and Vehicle Licensing Agency has a role to play here in assessing the current provision of training and issue of driver's licences. Increased acceptance of CAVs in society is likely to occur as the uptake of CAVs gains momentum, first by influencers, and then by general consumers. Furthermore, as the demographic shifts over time, younger, more technology receptive people will become a greater proportion of the driving population.

Consumer confidence can be greatly influenced by the media. As with a number of commonly held fears, it is often perception rather than reality that sways public opinion. To illustrate the intense scrutiny which CAVs are under to prove their safety, one only has to look at the media attention given to a self-driving car that ran a red light during a trial in the US in 2016,³⁰ as well as perceptions about safety, the consumer will also form perceptions of cost. Caution must be taken that actual or perceived higher premiums in insurance do not hamper the uptake of CAVs. This may also have the knock-on

effect of creating an impression that the technology is less safe. Widespread consumer education and communication from both government and industry is needed to remove these barriers to CAV acceptance.

9.2 Connectivity infrastructure

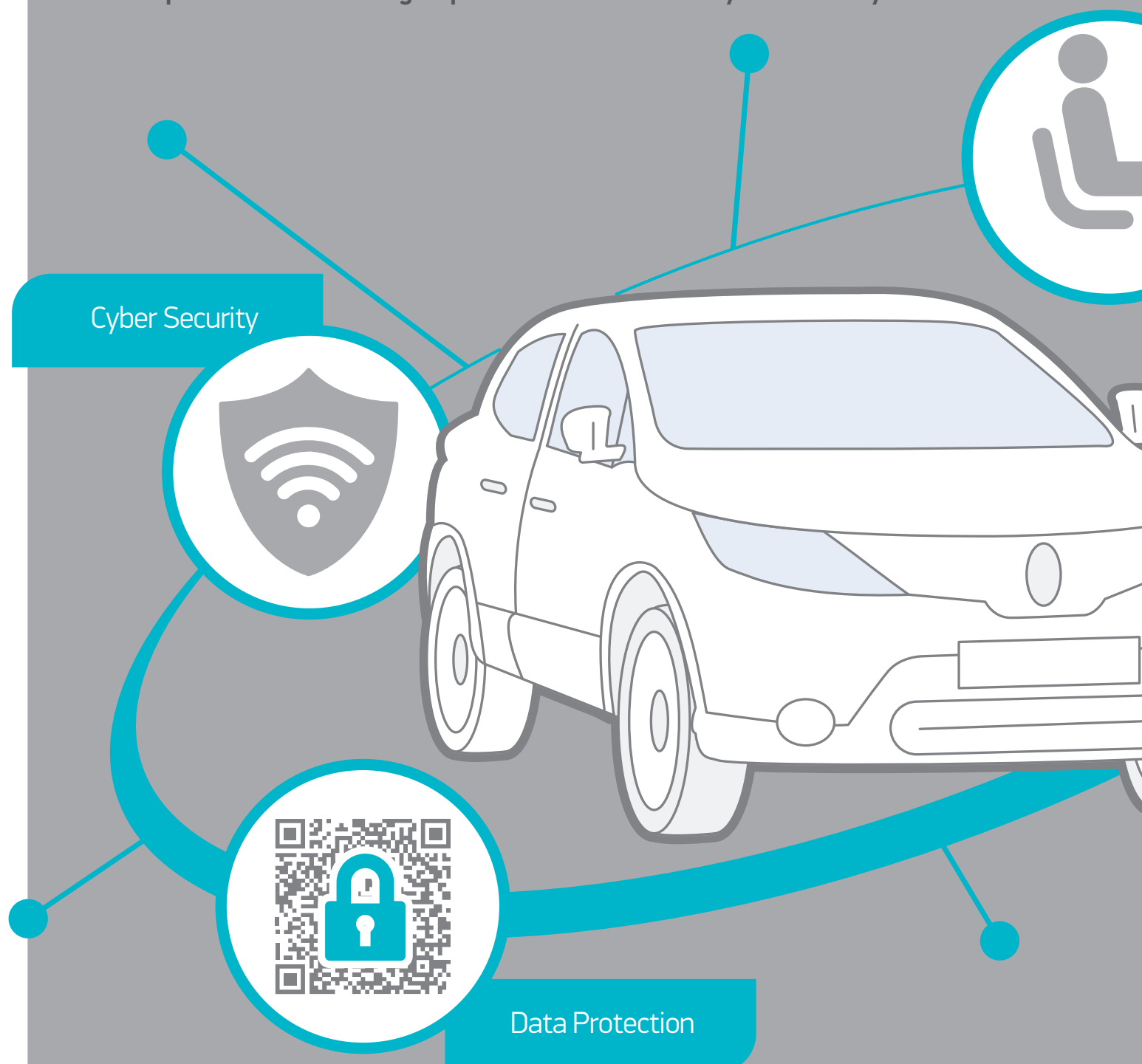
Central to the successful deployment of CAVs is connectivity and coverage and reliability in particular. In an increasingly connected digital ecosystem, the connectivity and digital infrastructure has to equal and or exceed the road infrastructure. While autonomous vehicles can operate effectively without connectivity, for instance using high-precision maps and sensors, the combination of these features and connectivity can significantly enhance functionality. Ubiquitous mobile internet coverage across the whole UK road network is critical to the successful roll-out of CAVs. Currently, less than 20% of UK roads currently have full 4G coverage, less than half of all roads have full 3G coverage, and 2% of roads (4,600 miles) have no 2G coverage from any network provider.³¹ Government is taking steps to address this challenge, and has pledged £16 million towards a National 5G Innovation Network, but much more needs to be done if the UK is to remain competitive.³²

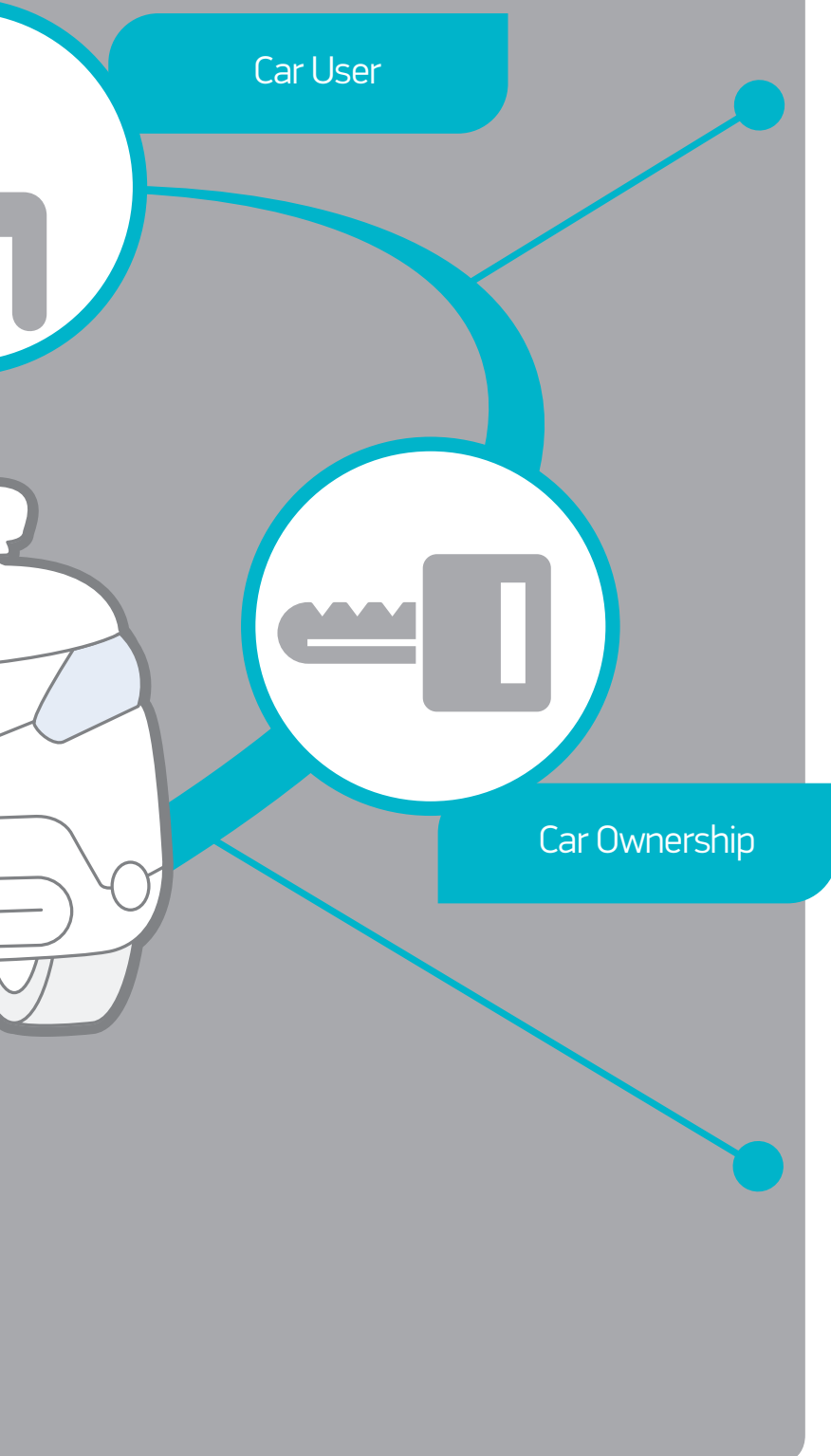
While the UK is positioned favourably at present for the testing of autonomous vehicles, some vehicle manufacturers have not identified the UK within their top three markets of choice to launch connected features, due to poor connectivity.



9.3 BUSINESS MODEL CHALLENGES

The way that consumers use, own and acquire vehicles is already changing, and the introduction of CAVs is likely to accelerate this. The business models of automotive manufacturers will need to evolve to reflect these changes, and adapt for the increasing importance of data and cyber security.





Car ownership

The rise in alternative transportation models such as car sharing and pay-per-use will play an important role in reshaping consumer mobility and traditional vehicle ownership. The automotive giants of today are already reacting to this, entering into a number of partnerships with innovative ride-hailing services, for example, Toyota and Uber, Volkswagen and Gett, General Motors and Lyft, Apple and Didi Chuxing (Chinese car-booking giant), Fiat Chrysler and Alphabet (Google's parent).

Car user

While market disruption from car sharing and pay-per-use is largely being pushed by external players, we anticipate that there will be an internal disruption resulting from the shift away from connected and autonomous features towards fully autonomous cars. With driverless cars, the role of the consumer and human-machine interaction will vastly differ from today. The current extremely low use of cars by private owners (approximately 5-10% utilisation each day), will likely become a thing of the past. Increased use will come hand in hand with a decrease in demand to purchase cars.

Data protection

Contrary to commonly held beliefs, the collection and use of data by CAVs is not a matter of significant concern for consumers. When asked about the perceived challenges of a fully connected and autonomous vehicle, only 15% of people aged over 65 stated loss of privacy as a concern, against 20% of 25 to 64 year olds and 22% of the young survey respondents. Nevertheless, automotive manufacturers will need to continue to ensure that robust systems are put in place to protect personal data so as to maintain consumer confidence in CAVs.

Cyber security

As the automotive industry becomes increasingly connected, more robust security measures and corresponding regulations will be required to ensure cyber security. Failure to address this challenge will not only reduce consumer confidence, it could also present genuine risks to public safety. Fortunately, for the automotive industry, issues relating to cyber security and resilience of the infrastructure are not solely their responsibility, but a component of the entire connected UK mobility network. Common to a number of the aforementioned challenges relating to the business model is the need for the automotive industry to operate effectively in an ecosystem with other industries, including technology, telecommunications, cyber security and insurance. ■



AS THIS REPORT HAS OUTLINED, THE UK HAS A LOT TO GAIN FROM CAVS. HOWEVER, THE UK WILL ONLY ENJOY THE MANY BENEFITS OF THIS TECHNOLOGY IF GOVERNMENT AND INDUSTRY WORK TOGETHER TO FACILITATE ITS DEVELOPMENT, TESTING AND ROLLOUT. WE RECOMMEND THAT THE FOLLOWING ACTIONS BE TAKEN:

■ **Increasing public awareness and acceptance of CAVs**

– Government and industry should work together to run an information campaign which dispels myths and highlights the many benefits of CAVs. By expanding people's horizons about the benefits of driverless vehicles through communicating the art of the possible, government and industry can pave the way for widespread acceptance within society. In addition, particular focus should be paid to the benefits that CAVs will bring to those with restricted mobility;

■ **Improve the UK's connectivity and digital infrastructure**

– Government must act urgently to ensure that mobile internet connectivity along the UK's road network is ubiquitous. Failing to do so would not only undermine the UK's competitiveness but delay the realisation in the UK of the benefits related to CAVs;

■ **Invest in R&D**

– Government and industry must continue to invest in research, development and testing in the UK. Significant investment has already been made, but as the competition to be the world leader in CAV technology increases, government must ensure that its investment in R&D matches that of other countries and is targeted in areas where the UK has a competitive advantage. Government must also ensure that the UK remains an attractive place for foreign direct investment, and the development of a UK CAV test-bed will support this.

CONNECTED AND AUTONOMOUS VEHICLES TO REVOLUTIONISE MOBILITY – UNLOCKING TRANSPORTATION RESTRICTIONS EXPERIENCED TODAY BY YOUNG PEOPLE, OLDER PEOPLE AND PEOPLE WITH DISABILITIES IN THE UK

Our study has determined that today's consumer has less mobility than is desirable due to restrictive transportation options. As anticipated, this is amplified in rural areas of the UK, where "distance to travel to get public transport and its frequency" are key factors.

While 55% of survey respondents claimed to be positively aware of CAV technology, the UK lags the 'tech-savvy' consumers in countries such as China, where, based on our recent survey, more emphasis is placed on in-car technology than on price or vehicle performance.³³ UK consumers in our survey do, however, have a positive interest in the potential benefits CAVs could bring when informed. The ability to attend higher education, better access to the jobs market and the possibility to have an improved social life were advantages that featured strongly. This implies CAVs can have a real impact on quality of life, and suggests that there is optimism among these social groups in future mobility solutions.

For the consumer, comprehension of the benefits of vehicles that are both connected and fully autonomous is limited only by their imagination. Few perceive cars as a mobile office or living space, where front seats re-orientate to face the rear, while windows become movie screens, safely navigating a family to its next destination.

The evolution of vehicles enhanced by connected and autonomous features has started and it continues to drive innovation that is challenging the automotive industry in many ways – revised thinking on legislation, new manufacturing processes and technology, components and systems with broader functionality, a variety of digital services, cost and time-to-market impact for vehicle product development are just a few of the many changes underway.

Innovation in software, hardware and services to realise the full potential of CAVs will not only require new technology and talent but will undoubtedly need the creativity of start-up environments, company collaboration and acquisitions to pool capability.

For the UK, much has been done but there remains much to do – both government and industry have a responsibility to raise consumer awareness of CAV technology, to help with both the perception and acceptance of vehicles of the future. Investment, partnerships and education are required to create an environment where innovation and the growth of leading technological capabilities thrive. The UK also needs a connectivity infrastructure with coverage across the entire road network to allow the deployment of CAVs in the future, whether they first emerge in commercial or passenger vehicles

“A great opportunity exists to make a positive impact on society through improved mobility, and the time to act is now”

Mark Couttie
Strategy® Partner

- **5G:** Fifth generation mobile wireless standard
- **Autonomous Car:** A car which is capable of fulfilling the operational functions of a traditional car without a human operator
- **Car sharing:** the practice of sharing a car for regular travelling, especially for commuting
- **CAV:** Connected and autonomous vehicle
- **Connected Car:** A car which has technology enabling it to connect to devices within the car, as well as external networks such as the internet
- **Mobility:** The ability to move or be moved freely and easily
- **NPV:** Net Present Value, a measurement of the profitability of a projected investment or project that is calculated by working out the difference between the present value of cash inflows and the present values of cash outflows over a period of time
- **OEM:** Original Equipment Manufacturers of vehicles
- **R&D:** Research & Development
- **Ride hailing:** hailing a vehicle for immediate service – fees are usually time and distance-based
- **Ride sharing:** passengers sharing vehicles – fees are often split between users
- **Testbed:** a cutting-edge technology facility for users to conduct a variety of tests on connected vehicles

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KEY STRATEGY& CONTACTS:

Mark Couttie

Partner, PwC Strategy&, Advisory, London

+44-782-432-8012

mark.couttie@pwc.com

Rich Parkin

Partner, PwC Strategy&, Advisory, London

+44-790-016-3731

rich.parkin@pwc.com

Darren Jukes

Partner, PwC, Deals, London

+44-796-629-7427

darren.jukes@pwc.com

Cara Haffey

Partner, PwC, Deals, London

+44-780-955-1517

cara.haffey@pwc.com

Shelly Luciano de Oliveira

Manager, PwC Strategy&, Advisory, London

+44-787-281-5682

shelly.luciano@pwc.com

Rachel Drapper

Associate, PwC Strategy&, Advisory, London

+44-784-146-7267

rachel.drapper@pwc.com

THE SOCIETY OF MOTOR MANUFACTURERS AND TRADERS LIMITED

71 Great Peter Street, London, SW1P 2BN

Tel: +44 (0)20 7235 7000

E-mail: communications@smt.co.uk

 :@SMMT  :SMMT

www.smt.co.uk

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