Rail in the future transport system

Evidence paper

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1. Introduction

1.1 Ever since the first pioneering steam trains of the 19th century the railway in Great Britain has been required to continuously evolve its role. The urbanisation in the decades that followed the first railways, the rise of cars as a ubiquitous transport mode in the mid-20th century, affordable air travel, and the growth of the commuter rail market have each in different ways shaped the rail sector that operates today. Technologies have advanced, allowing the sector to improve performance – providing safer, more reliable and quicker travel, for example. And the demands placed on the system by its users have also changed. Further adaptation will be necessary in the decades to come if Great Britain is to take full advantage of the opportunities that the railway offers.

1.2 This paper sets out the social, economic and technological changes that are likely to provide the context for the sector over the next 10-20 years. We have seen shifts across society in areas such as socio-demographics, economic activity and technology, and this has affected how we live, work and travel.

1.3 Chapter 2 reviews the social and economic shifts that could shape transport demand over the next 10-20 years. The impacts of developing digital technology, and the new business models it enables, are considered in Chapter 3.

1.4 Passenger expectations are also changing – from when and where people travel, to the quality of service that passengers expect. There is an emerging expectation of seamless integration across transport modes. Some companies already act as 'mobility intermediaries' and offer services across all modes. Chapter 4 sets out the challenges and opportunities of ensuring rail fits into an integrated transport system and describes five areas in which the railway is likely to need to build resilience in response to possible future changes across the transport landscape.

1.5 Finally, as with any service industry, the capabilities of the people who work on the railway will be important for ensuring the sector thrives under any future scenario. Chapter 5 explores the opportunities and challenges for the rail workforce likely to arise from the wider shifts discussed in the preceding chapters.

1.6 Whilst we are unable to predict the future, we can be sure that Great Britain will need a railway that can adapt to technological developments and broader social and economic changes at a similar pace to other transport modes, to be fit-for-purpose for tomorrow's passengers.

2. The changing social and economic context for transport

2.1 The economic environment over the last decade has been characterised by uncertainty, with economic performance struggling to return to levels seen before the financial crisis of 2008. Despite record levels of employment, earnings have not kept pace with prices.[1, 2] Alongside this changing economic picture, a growing but ageing population are making new choices about where to live, how to spend their time, and how they want to travel.

Key socio-economic trends likely to affect rail demand

Ageing population

The UK population is getting older, a trend seen around the world, particularly in developed countries.[3] This is forecast to continue, with a greater proportion of older people and a declining proportion of younger people.[4] As of 2016, there were 12.4 million people of pensionable age, and by 2041 this is projected to grow to 16.3 million.[5] Over the same period, the number of children under 10 is projected to fall from just over 8 million to just under 8 million, despite the overall population growing.[6]

Urbanisation

More people in the UK are moving to live in cities[7] with urban densification driven by younger people moving to city centres.[8] Much of this urbanisation has taken place in London, which is now home to 13% of the UK population.[9] Although the rural population in England increased from 9.1 million in 2011 to 9.5 million in 2017, this represented a fall in the proportion of the total population.[10]

New business models

The sharing economy and new business models in companies such as WeWork, AirBnB, Uber and Deliveroo have created changes in economic activity and employment patterns, dramatically altering the landscape in their respective markets. Globally, these markets were valued at $15 billion in 2014.[11] There are bold projections of further growth, with some estimating that it could increase to $335 billion by 2025, with millennials driving this growth.[12]

Digital nation

Digital infrastructure investment has enabled an increase from 9% to 90% of UK households having internet access in the last 20 years.[13] Since 2012, there has been a four-fold increase in the number of superfast broadband connections and a near four-fold increase in residential fixed broadband download speeds.[14] In 2011, only 27% of adults used a smartphone; by 2018 this had grown to 78%. Data consumption has also increased dramatically – smartphone users consumed an average of 0.2GB of data each month in 2012; by 2017 this had grown to 1.9GB.[15]

Impact on travel behaviours

2.2   These developments are affecting travel behaviours – compared to 15 years ago, fewer trips are being made and shorter distances travelled.[16] However, within this context, rail travel has increased overall, even though commuting journeys have fallen.
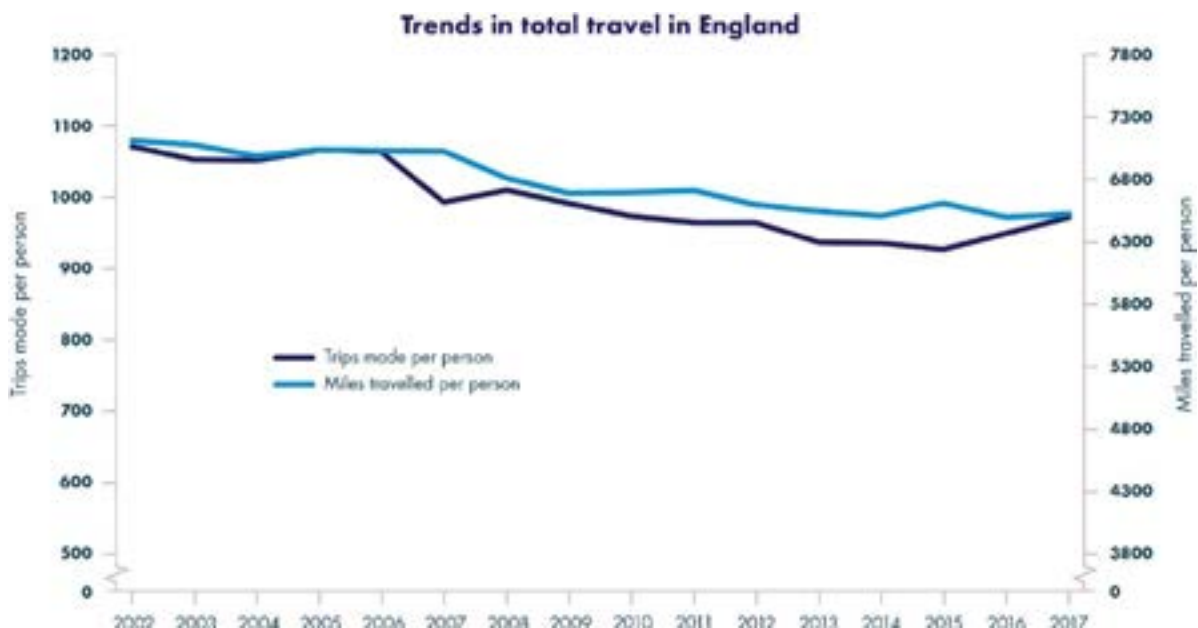

Figure 1. Trends in total travel in England[17]

Commuting

2.3   One of the reasons for the overall decline in trips made and miles travelled per person is changing working patterns. The number of commuting journeys has decreased, due to flexible working, part-time and self-employment and more people working from home.[18] A study by the Work Foundation suggests that we are at the 'tipping point' of mobile working in the UK, with over 70% of organisations expected to offer remote working by 2020.[19] As digital technologies and broadband connections continue to improve, this could enable greater adoption of flexible working practices.

2.4   Further growth in home working is likely to be embraced most by those who are otherwise most likely to be heavy rail users,[20] which could have a big impact on rail ridership as around half of all rail journeys are for commuting.[21] Increasing flexibility in work hours may also lead to further reductions in peak-time ticket sales, decreasing revenues for the industry. On the other hand, flexible working, combined with improved yield management, offers scope to reduce traditional morning and evening commuter peaks and make better use of the rail network at other times. This could improve the passenger experience through reducing over-crowding and the need for costly and disruptive upgrades to the rail network in order to expand capacity at peak times.
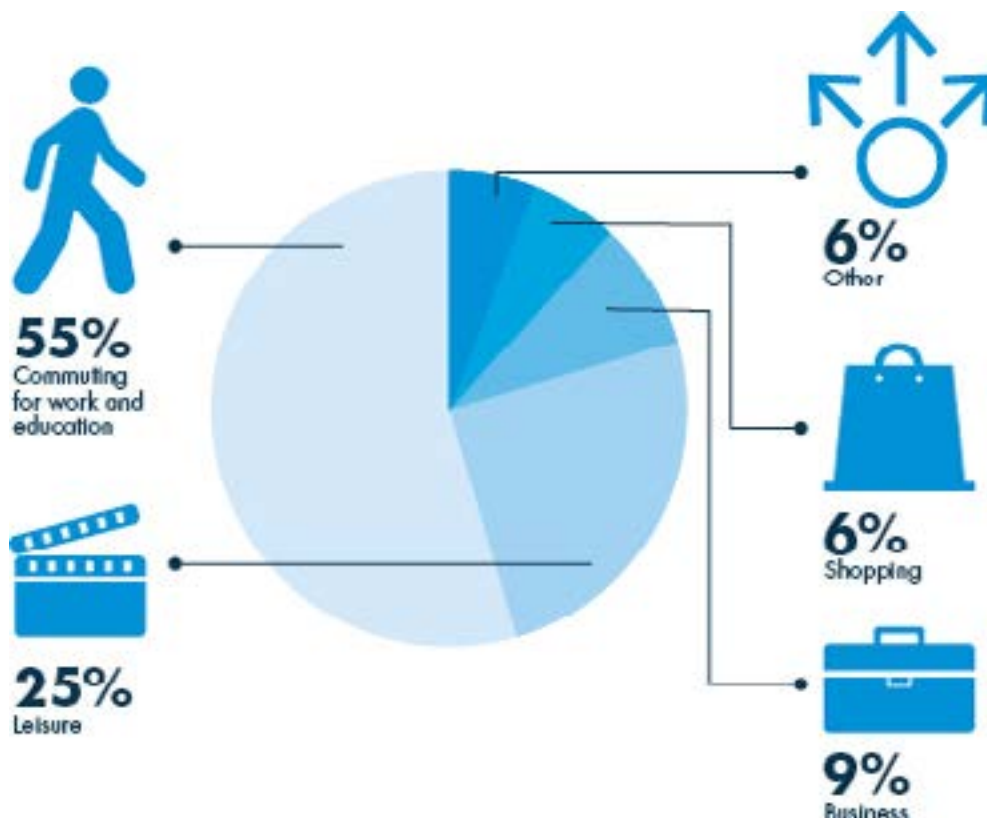

55%
Commuting for work and education

25%
Leisure

6%
Other

6%
Shopping

9%
Business

Figure 2. Rail demand by journey purpose (England, 2017)[22]

Employment market

2.5   The types of jobs that people do is also significant for the future of rail as higher income has been associated with a greater propensity to travel by rail.[23] In the last two decades, we have seen job growth in categories associated with a high proportion of rail commuters. Sectors that have seen jobs double between 1995 and 2018 include information and communication services, professional scientific and technical work, administrative and support services and real estate services. At the same time, jobs have declined in sectors such as manufacturing, where rail is less commonly used as a means of transport.[24]

2.6   In the longer term, increased automation is likely to have implications for the jobs market. The Office for National Statistics estimates that around 1.5 million jobs in England are at risk of automation.[25] According to PwC, while artificial intelligence (AI), robotics and other forms of automation are likely to generate additional jobs overall, they will also displace current jobs. PwC predict that in the shorter term (in the early 2020s), the largest impacts of automation could be on sectors like financial services where algorithms could lead to faster and more efficient analysis and assessment.[26] These changes could have an impact on rail demand, as people working in the financial sector are more likely to use rail.[27]

Leisure travel

2.7   As the number of commuting journeys has decreased, the share of leisure travel in rail trips has been growing.[28] Population growth and the rise of the 'experience economy', where people spend money on experiences such as leisure trips, rather than possessions, could potentially lead to more journeys being taken. It is also significant that population increases in the centres of large cities have been driven by young, highly educated single residents[29] and young people are less likely to own and use a car.[30] It is uncertain whether these different behaviours will continue as these young people age or if the behaviours of young people in the future will be different.
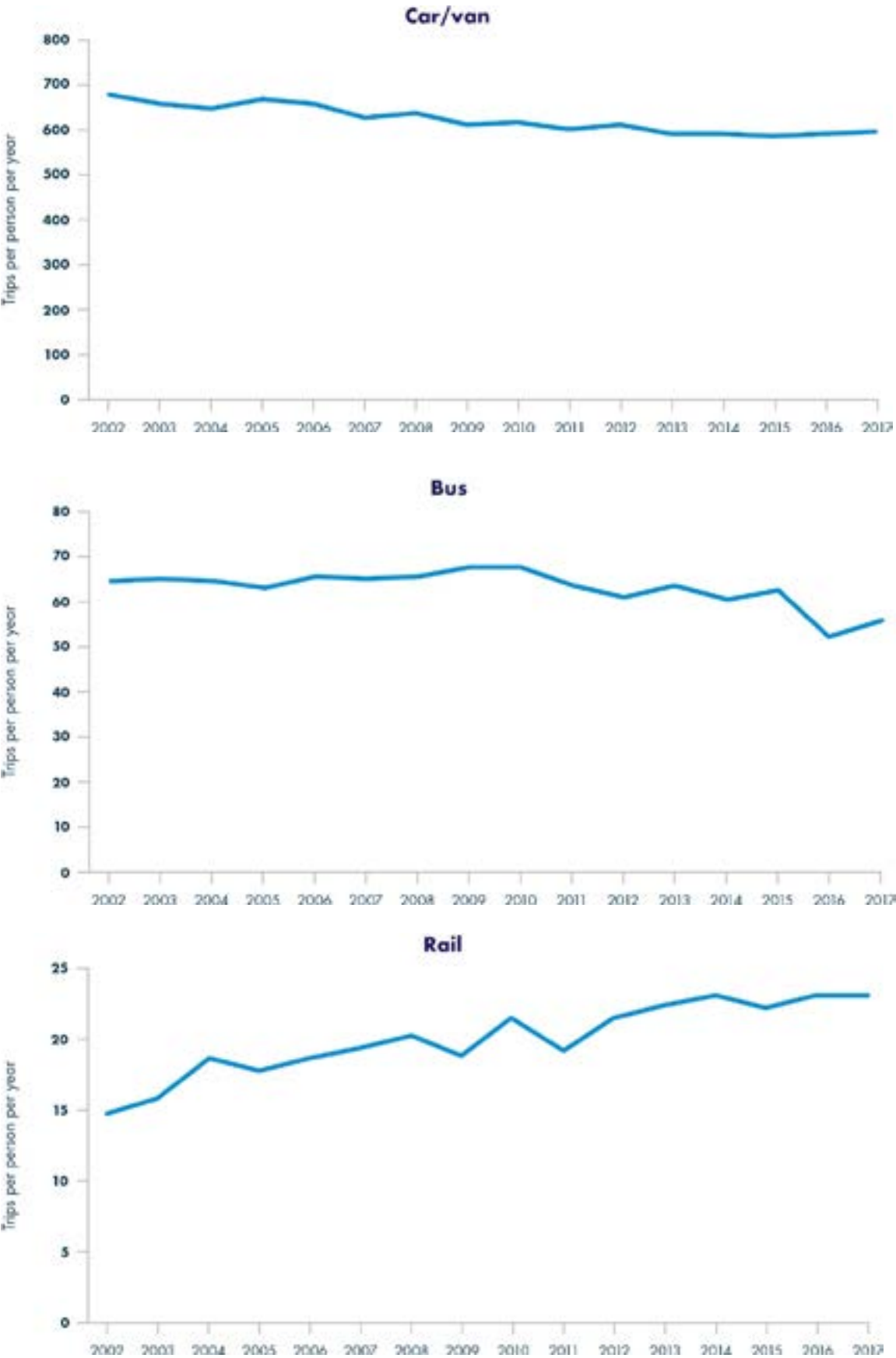
Figure 3. Car/van, bus and rail trips per person per year (2002-2017)[31]

Note that these charts have differing scales.

Choices of mode

2.8 There are indications that preferences of mode choice are shifting. The overall decline in trips made and miles travelled per person has been driven by a decline in car and bus trips. Rail travel, despite a temporary dip in ridership in 2017-18, has increased over the last 15 years by 56% (although people still take far fewer rail trips than by car overall).[32] According to the Independent Transport Commission, this is because more people are using rail as opposed to existing rail users travelling by rail more frequently.[33] This is consistent with fewer journeys being made by rail with season tickets and the increasing share of leisure travel.

2.9 There has been a decline in the number of driving licences held by young people[34] which could lead to an increase in the use of other modes, such as rail. However, increasing expectations of immediate and personalised services could reduce the attractiveness of rail services. Between 2005 and 2018 there was a 55% increase in total licensed Private Hire Vehicles (PHVs) in England (with a 120% increase in London),[35] and recent research suggests there is a possible link between the rise of Transportation Network Companies in American cities (such as Uber and Lyft), and declines in rail and bus ridership.[36] Another study found that after using ride-hailing services, the average net change in public transport use was a 6% reduction among Americans in major cities.[37]

Goods

2.10 Online shopping, and the increase in deliveries directly to the home, are changing the way that goods are moved, with an increased need for delivery vehicles, and the need to connect freight depots with large, sometimes out-of-town, distribution centres. The trialing of drones for home delivery has begun in the UK, and in the future, widespread commercial deployment of delivery drones could reshape home delivery services.[38] Whilst rail freight can never provide "final mile" deliveries there is scope for it to benefit from this trend.

3. The changing transport context and the future of mobility

3.1 As the pace of change of how people and goods move around our towns, cities and countryside accelerates, we are beginning to see the impact on transport. The precise nature of future change is unpredictable, but we can expect to see significant change in three principal areas.

(1) Automation

3.2 Automation is growing across the transport sector as more and more functions are computer-controlled, bringing potentially significant safety, cost and efficiency benefits.

3.3 Automated or self-driving vehicles are those that have the capability of driving themselves without human oversight or intervention for some, or all, of a journey. In an automated vehicle the driver can, in at least some circumstances or situations, hand all control and responsibility to the vehicle and effectively become a passenger.

3.4 In the future, we are likely to see a step change in levels of automation which could lead to a range of social benefits through enhanced safety, increased capacity, better utilisation of urban space and improved accessibility. There are also risks from increased levels of automation: for instance, if automation makes motorised door-to-door travel easier and cheaper for the consumer, it could decrease the incentives for active modes of travel, potentially worsening health outcomes.

3.5 Increased automation is likely to affect road traffic, including taxis, private hire vehicles, buses and cars. Self-driving cars have been tested in the UK since 2015, and by 2021 there will be trials of an automated bus service between Fife and Edinburgh, and self-driving taxis in London.[39] In rail, the European Rail Traffic Management System (ERTMS), an advanced train-protection and signalling system capable of supporting the semi-automatic running of trains, is being installed on parts of the Thameslink and Crossrail lines in London, with ambitions to roll it out further.[40] The Docklands Light Railway has operated as an automated light railway system in East London since 1987.

3.6 Automation will require workforces to adapt and become more customer facing, which research has shown is what customers want. According to the Organisation for Economic Co-operation and Development (OECD) there is an almost 60% probability of the role of road transport drivers becoming automated in the future.[41] These developments could equally have a number of implications for the rail sector workforce, with the need to adapt to these changes and upskill to meet new operational business requirements.

(2) New business models

3.7 Approaches to providing transport services are changing and businesses are capitalising on the sharing economy. New technology is enabling new economic models, including demand-driven services such as Ride by Citymapper, and real-time pricing and yield management approaches such as surge pricing on Uber. Multimodal transport partnerships are being formed; for instance, third party ticket retailers offering train and coach tickets.

3.8 There has also been growth in car leasing, finance and hire purchase – an alternative to purchasing and owning a car outright (at point of purchase). This is blurring the distinction between ownership and temporary ownership of vehicles. The sharing economy also presents opportunities for freight, with businesses beginning to exploit the commercial potential of 'backhauling' (the filling of reverse empty flows with other goods) and 'crowdshipping' (which involves delivering parcels by picking up and dropping them off along routes that were being taken anyway).

(3) Cleaner transport

3.9 Rapidly falling battery prices,[42] improvements in energy density and electric motors, and developments in alternative fuels, are reducing the carbon and air quality impacts of road transport in particular. The number of electric vehicles registered in the UK is already increasing,[43] and the Government's Road to Zero strategy has set an ambition for all new cars and vans to be effectively zero emission by 2040, enabling the UK to be at the forefront of the design and manufacture of zero emission vehicles.

3.10 In aviation, electric and hybrid aircraft have the potential to reduce emissions.[44] In 2018, it was announced that £343 million will be invested by government and industry into researching these technologies in the aerospace sector,[45] and £106 million has been pledged for research and development in zero emission vehicles, new batteries and low carbon technology.[46]

3.11 Smarter use of the logistics system could also contribute to reducing air pollution, with estimates that efficient driving could save more than 2.5 megatonnes of CO_2 in 2035 (equivalent to 12% of emissions from HGVs in 2016).[47] This in turn would contribute to the UK's commitment to reduce CO_2 emissions by 80% of 1990 levels by 2050.[48]

3.12 On the other hand, even whilst carbon emissions from exhausts decrease, we have come to better understand the harmful effects of particulate emissions from non-exhaust sources. In future, the particulate matter emissions from brake, tyre and road wear may become of even greater concern than that from the exhaust,[49] and addressing carbon emissions will only go some way to tackling the growing issue of air pollution.

3.13 However, if other transport modes become greener, the case for investment in the railway could change. Today, rail is more environmentally friendly than cars since it produces significantly lower CO_2 emissions per passenger kilometre.[50] The Department for Transport's Rail Freight Strategy states that each tonne of freight transported by rail reduces carbon emissions by 76% compared to road (as of 2016).[51]

Rail freight emits 76% less CO_2 than road freight per tonne km

3.14 In January 2019, the Rail Industry Decarbonisation Taskforce presented an interim report responding to the Minister for Rail's challenge to the industry to remove all diesel-only trains from the network by 2040, and to provide a vision for how it will decarbonise.[52]

Future of mobility

3.15 It is not possible to be definitive about the impacts of these factors on future rail demand, but it is almost inevitable that there will be implications. The reasons why people travel, when they travel and whether they choose to take alternative transport could all change. Rail travel has always been most competitive in dense urban areas and particularly for commuters to London; as the places where people live change, so could the demographics of rail's core users. The share of leisure travel in rail trips has also been growing. Social factors such as flexible working and leisure trends can all have a significant impact on rail demand as they influence the frequency and length of rail trips.

3.16 These changes in demographics, lifestyle choices and travel behaviours are happening concurrently with extraordinary innovation in technology, engineering and business models. Social changes in the last 20 years have altered how and why we use the transport system; shifts over the next 20 years are likely to be even more significant. To assist the Review and the wider sector in planning for the future, Annex A sets out three hypothetical scenarios for the wider transport system based on three key parameters of changing working patterns, digital integration, and the value placed on public transport. This is not a full list of determinants, and the possible combinations of these and other factors which will determine the future transport landscape are almost infinite. Many of these factors are beyond the control of policy makers and industry. Nevertheless, they need to be alert to the full spectrum of these possibilities to ensure the railway is resilient to future change and uncertainty.

3.17 New and better ways of transporting people and goods have the potential to increase productivity and reduce transport costs; they can also push the boundaries of existing regulatory structures and raise issues around privacy and security. Self-driving or automated vehicles could enable more efficient use of road space (by vehicles being able to travel closer together) and improve transport inclusivity; on the other hand, automation has the potential to change the need for labour in numerous business processes, thus eliminating the need for travel across a whole range of activities. Congestion could also be an issue: the implication of automated road vehicles coupled with cleaner transport is that there may be a cheaper, higher volume of road-based transport. In inner London and other urban areas, the capacity for increased road traffic is very limited, with little to no scope to increase road space. New technologies could also lead to shifts away from traditional mode choices for certain types of journey – for example, Volvo has ambitions for their driverless vehicle, 360c, to rival short haul air travel.[53]

3.18 These trends in society and the economy, developments in technology and new business models are likely to influence the market for rail both directly and indirectly. Social changes will influence the location of households and employers and shape the structure and location of economic activity. Changes in transport could alter the relative attractiveness of rail, through the development of alternatives offering shorter journey times, greater convenience or cheaper fares. We have already seen the use of apps to pay for travel and to get up to date journey information, and the advent of market disruptors such as Uber. Other modes could become much greener, as battery technology improves and low emissions vehicles become more common. The rail sector will need to adapt to this changed context in order meet passenger requirements in the future.

3.19 In recognition of the opportunities presented by this transformation, the future of mobility was identified as one of four interlinked Grand Challenges in the Industrial Strategy.[54] Achieving ambitions for future mobility will help the UK meet the needs of an ageing society, capitalise on UK strengths in artificial intelligence and data and support clean growth.

Industrial Strategy

The aim of the Industrial Strategy is to boost productivity by backing businesses to create good jobs and increase the earning power of people throughout the UK with investment in skills, industries and infrastructure. The Industrial Strategy sets out Grand Challenges to put the UK at the forefront of the industries of the future, ensuring that the UK takes advantage of major global changes, improving people's lives and the country's productivity. The first of the "4 Grand Challenges" are focused on the global trends which will transform our future, comprising: artificial intelligence and data, ageing society, clean growth, and future of mobility.

3.20 Despite the transformation of transport expected over the coming decades, it is likely that there will continue to be a need for a mass transit system. The government's 'Future of Mobility: Urban Strategy'[55] includes a principle that mass transit remains at the heart of our transport system. This is because of its ability to efficiently transport large numbers of people relatively quickly to high density centres. Individual motorised transport, however powered or driven, is not able to replicate this; the railway, on the other hand, could continue to meet this need. However, to compete effectively and fit into our future transport system, the rail sector needs to enable innovation and to operate effectively alongside other modes.

Integration across transport modes

3.21 It is essential that the railway can respond to these changes in an agile way, and is both flexible and resilient enough to adapt quickly in a transforming environment and meet the needs of its future customers.

3.22 If the rail sector does not enable better integration with other modes, passengers may lose out on benefits, and the rail sector may lose prominence in the wider transport system. Specifically:

- services may fall short of passenger expectations;

- passengers may increasingly choose other transport modes where possible; and

- opportunities could be missed to increase utilisation of assets and to generate increased revenues.

3.23 The boundary between technological innovation inside and outside the transport sector is blurring. 'Mobility intermediaries' are demonstrating how digital platforms can enhance integration across different transport modes and provide more convenient ways of paying for these services.

3.24 These services vary in the extent of modal integration. In France, the national railway provider SNCF is becoming a shareholder in the digital ride-sharing specialist BlaBlaCar under a multimodal partnership to enable it to offer integrated, multimodal ticket options to its customers.[56] In the US, Uber has begun offering public transport options alongside its taxi services, with the promise that soon customers will also be able to pay for public transport through the app as well.[57] Other companies are already offering Mobility as a Service (MaaS) products. Whim in the West Midlands allows customers to take journeys by a range of transport modes on a pay as you go basis through their app and have recently launched a subscription service.[58] In London, Citymapper Pass offers users unlimited Underground, bus, bike and shared cab services through one integrated card and app.[59]

Mobility as a Service

Mobility as a Service (MaaS) is the integration of various modes of transport along with information and payment functions into a single service. Customers can choose and pay for an entire end-to-end journey using different transport modes, all through a single platform.

The recent Transport Select Committee report on MaaS, and the Government's subsequent response, discuss in more detail some of the opportunities and potential challenges presented by MaaS platforms for the transport sector.[60, 61]

3.25 These products are being developed in response to the growing demand from users for transport to be delivered as an on-demand, multi-modal service that allows passengers to travel door-to-door conveniently and seamlessly. These integrated approaches present an opportunity to enhance passengers' journey experience, deliver more sustainable transport, improve UK productivity and help to enable greater social inclusion. However, there are potential downsides. One unintended consequence of integrated platforms, for instance, could be increased congestion and/or a decrease in walking or cycling because

of better access to taxi services. It will also be important to ensure that these platforms do not create other adverse outcomes, such as reducing access to transport services for the minority who are not able to access digital platforms.

3.26 An alternative to subscription services is the Pay As You Go (PAYG) model, as provided by TfL. This approach may be more suitable for some users as it enables pricing and ticketing systems that are flexible and do not penalise intermodal or non-regular journeys. This enables consumers to opt for MaaS subscription type models (where a monthly fee is paid and covers all travel in the area) or use PAYG, according to their own individual needs.

3.27 There is more to transport integration than digital platforms. In terms of physical infrastructure, stations are generally served to a greater or lesser degree by car parks, bicycle racks, taxi ranks and bus stops. Many airports, although not all, are served by a railway. Station Travel Plans are used by station operators to coordinate onward and inbound transport options for rail passengers at each station, for example by considering taxi ranks and bus stops, and connections with light rail services. These can be used as a mechanism to bring together diverse groups with interests in rail – including community rail partnerships, local businesses and charities – who understand local needs, to develop common objectives and an agreed approach. However, although local authorities will seek longer term improvements to an interchange, a station operator (often a train operator) will not typically be incentivised to take the same long term view and may not consider action beyond their committed obligations or franchise term. The role of Network Rail and the station operator can also be unclear to local transport providers and partners.

3.28 More could also be done to integrate with other modes at a system level to improve day to day operations. For instance, today there are no mechanisms for coordinated approaches between road and rail transport if, say, there is considerable disruption on one particular mode in order to forewarn the other to expect higher volumes of passengers than usual.

4. Shaping the future railway

4.1   There are a number of areas and opportunities which could be embraced, to equip the rail sector to ensure it is able to respond to the needs of tomorrow's customers. These include the following issues, discussed in more detail below:

- how to improve services for passengers, in an age where technology has increased expectations of communications and customer service;

- the need to align incentives between different stakeholders, to support change;

- the importance of innovation, and how to encourage more of this across the sector;

- the way in which digital connectivity along railway routes could enhance train operations; and

- the role of data, what is collected and how, and the way in which it is shared.

4.2   There are a number of agreed strategies addressing the issues outlined in this paper. The Transport Infrastructure Efficiency Strategy[62] promotes efficiency through increasing understanding of cost and performance through benchmarking, and exploiting digital and innovation technologies. Steps have also been taken to facilitate third party involvement and investment in the railway. The Department for Transport's Market Led Proposals guidance, published in 2018, provides a tool to help promoters and investors develop credible proposals which would not necessarily be identified through the existing rail industry long term planning process.[63]

Rail Sector Deal

In December 2018 Government signed a deal with the rail industry to provide a catalyst to the rail sector to deliver more for society by encouraging new entrants to the market, harnessing technology to drive innovation, and ultimately benefiting communities across the country by improving services and creating more opportunities for growth. The underlying objectives of the deal are embracing digital technology, making better use of data and improving ways of working between government and industry. The Sector Deal also seeks to improve innovation through involving industry at the strategic planning stage.

As part of the deal a new data portal will be developed to enable more intelligent use of data, increasing collaboration and the exchange of ideas between the rail industry and other sectors, predicting and fixing problems on the rail network before they arise, and developing new products for passengers such as better journey planning apps. Implementation of the sector deal will also reduce the cost of digital signalling to below that of current conventional alternatives. Improving the performance of the rail supply chain will enable UK companies to deliver a better railway at home and to export world class goods and services.

4.3 These plans will take time to deliver and embed, and there is scope for more to be done. Other modes of transport are changing rapidly and the rail sector finds that difficult: railways include characteristics which are inherently inflexible, including infrastructure and rolling stock (with very long asset lives), seating layouts, timetables and destinations which are difficult to change at short notice.

Improving services for passengers through technology

4.4 With the proliferation of personal connected devices, people expect to be 'always connected'. In 2017, 70% of commuters stated that they used their smartphone during their journeys, with key services including: sending messages and emails; using social media; browsing the web; and online shopping.[64] 42% believe that the internet is essential for them to complete personal tasks during their commute and 32% use it in a work capacity.[65]

Personalised messaging trial

The Rail Delivery Group (RDG) have partnered with Zipabout, a tech development company, to use industry data to communicate personalised travel and disruption information directly to individual customers through Facebook Messenger. Customers are warned of disruption to their journey and are offered alternative options. The trial recently expanded to include automated compensation notification, sending customers a link to Delay Repay/ compensation if the train arrives later than the journey threshold.

4.5 There is intermittent connectivity available to passengers on the railway, which is provided either directly to devices through passengers' mobile network provider, or through the provision of WiFi at stations or onboard. Both means are unreliable: in densely populated areas, the number of people on networks means that the throughput can be insufficient to meet demand; in more rural areas, the prevalence of 'not-spots' means that the mobile network signal, which both devices and WiFi equipment need to connect to, is not always available. The prevalence of deep cuttings and tunnels around the network poses a further challenge. In 2018, nationally, only 33% of passengers reported that they were satisfied with the reliability of onboard internet connectivity,[66] and only 85% of train carriages are fitted with WiFi capability.[67] Steps will need to be taken if this is to improve: data demand is increasing, and Ofcom has estimated that to meet passengers' connectivity requirements in 2025 would require as much as 1.7Gbit/s to the train.[68]

4.6 The provision of better digital connectivity, through reliable onboard WiFi or directly via external transmitters, would allow train users to employ their travel time effectively which would increase productivity and presents a big opportunity for the railway to maximise its advantage over other modal choices such as driving. It would also allow the full benefits of integrated mobility services, enabling dynamic systems for booking onward travel by other modes. With the growing prominence of digital technology and services in our lives, it will increasingly become the norm, not the exception, for seamless, high bandwidth connectivity to be embedded within operational infrastructure and made available directly to consumer devices.

4.7 This connectivity would also allow transport providers to enhance the passenger experience through improved operations, such as the provision of smart ticketing and better accessibility and travel information. This would help meet changing passenger expectations about levels of service; passengers identified being kept better informed as a top ten priority for improvement in Transport Focus's

research into passenger information during planned and unplanned disruption.[69] Swifter delivery of more frequent and accurate communication updates, agreed between staff in a control centre and those on a train or platform, would, in turn, ensure consistent messaging to passengers across different mediums, for instance, via loudspeaker announcements on the train, or through the National Rail app. However, the costs of deploying the necessary equipment and infrastructure could be prohibitive, and with the financial benefits spread across a number of parties, it is unclear how the necessary funding could be realised.

Aligning incentives

4.8   Stakeholders across the rail industry hold a divergent range of interests, and this fragmentation can mean it is difficult to reach consensus on a coherent approach to change. This makes the role of an overarching authority particularly important, in order to coordinate all stakeholders in a joined-up approach, to hold accountability and build towards a long-term strategic vision. In recognition of this, the Department for Transport published the Strategic Vision for Rail in 2017[70]. Without such a strategy, it will be hard for the railway to respond to a rapidly changing world.

4.9   The ticketing system is a good example of misaligned incentives, where stakeholders have competing concerns. Although the ticketing system is increasingly digital, it is still inflexible, with retailers' changes to product structure reliant on the capability of front office ticketing infrastructure – which is owned, managed and operated by a different party. Competition between third party and operator retail activities, and the structure of commission fees, also leads to misaligned incentives and high barriers for entry for innovative new market entrants.

4.10   In some cases, incentives are not always aligned for implementing improvements for customers. For instance, the realisation of digital signalling could result in huge benefits for Network Rail, including reductions in Schedule 8 payments to train operators. £220 million was paid to franchised train operators by Network Rail in Schedule 8 payments in 2017/18.[71] But Schedule 8, by protecting operators from the revenue impact of poor performance, means that operators have less of an incentive to help improve the network. The implementation of the Digital Railway programme to improve signalling requires operators and rolling stock companies to collaborate with Network Rail on train fitment. Retrofitting trains can be expensive and disruptive as train sets have to be taken out of service and it makes them more complicated and difficult to maintain.

Encouraging innovation

4.11 There is a common perception that the rail industry intrinsically finds it difficult to innovate. To some degree there will always be an inherent tension between the pace of technological change, and the rate at which this can be adopted by the railway in practice. This is true of any sector reliant on major infrastructure and long-term planning.

Innovate UK

Through actively working with industry on a portfolio of projects worth up to £37 million, funded by the Department for Transport, Innovate UK has been encouraging the uptake of new products across the rail sector since 2017. Recent projects which have subsequently begun commercial rollout include Moses, a taxi-sharing service which is used by passengers during periods of disruption to reduce alternative journey costs, and Transreport, which makes it easier for passengers who require assistance to book help during their journey.

4.12 The rail industry has demonstrated that it is capable of developing, borrowing and enacting innovations. Notable examples include tilting trains, Integrated Electronic Control Centres and remote asset condition monitoring. Certain aspects of the current structure of the rail sector make innovation more challenging, indicating a case for change.

4.13 For instance, at present, the sector is seen as a difficult market for new entrants or disruptors. Contracts and procurement frameworks can carry restraints considered onerous by small business and entrepreneurs, and are difficult to access, as is navigating approvals processes even for non-safety critical technology. For third party ticket retailers, approvals processes and retailing regulations set by RDG to secure network benefits are perceived to lack clarity, can be prohibitively costly, and take a 'one size fits all approach'. This is less accommodating of start-ups or small businesses. On infrastructure, Network Rail sets out processes for approving innovative ideas or products for use on the network, which are designed to provide adequate assurances around safety, reliability and compatibility with existing assets. Network Rail's Open for Business programme was established in part to improve this, by updating and streamlining standards, and inviting stakeholders to suggest further improvements.[72] This will take time. More widely across the sector, the product acceptance process can be viewed as cumbersome and unnecessarily bureaucratic, inhibiting the route to market for innovations and acting as a disincentive for innovators or those seeking to import technologies from other sectors or international railways.[73]

4.14 Another issue is the challenge of benefiting from innovation within the period of franchise agreements. Since privatisation we have seen innovation in some areas. Train operators are improving the information available to passengers, allowing them to make more informed decisions about their journeys. Real time information via screens on trains and at stations and through new customer apps are being introduced. Passengers are also being provided with live information about seating availability and crowding levels, so that they know the best place to stand on the platform to board trains. Several train operators now give Nectar reward points to customers when they purchase tickets.

4.15 However, there are concerns that fragmentation means there are no clear means of exploiting innovation for the benefit of the rail sector as a whole,[74] as opposed to the narrow commercial interests of individual stakeholders.

4.16 The current franchising approach is built around strong competition (and consequently incentive and opportunity for innovation) during the franchise bidding process, but the commercial incentives for further innovation during the contract are weaker, unless it can deliver short-term commercial benefit. Although there may be competition with other modes, especially in the long-distance market, many rail markets are inelastic, for example commuter markets. The life term of new assets, often exceed the length of franchise agreements although there are examples of innovation spanning franchise durations, for example rolling stock leasing and the barcode cost recovery charge. Risk sharing provisions introduced in franchise agreements through the contract change mechanism provision mean that operators do not get to keep all the benefits of innovation, and the scale of some franchises may also be too small for significant long-term investments. It is also very difficult to have innovations developed and 'ready-to-go' before a franchise is awarded. Although it is possible for an owning group to develop "oven ready" innovation schemes, detailed implementation plans can only begin after award, resulting in a 'squeeze' effect, where any available funds for innovation need to be spent in a short period of time.

4.17 Finally, benefits may arise from greater transparency on indicative costs of partnering with Network Rail, or other industry stakeholders, and on details of the asset base. To open the rail sector up to the market, potential investors need to be able to easily access information about what infrastructure could be available, its condition, where it is located and on what terms it could be used. This would allow third parties to explore the potential that the rail network could offer and propose commercial ventures, either to provide services for the railway or using the railway as a springboard to service other markets. Collecting this data, standardising it and making it accessible could enable commercial ventures and lead to possible enhancements for the railway, benefiting the sector through

additional revenue streams and providing better value for money for its assets. However, this information is unlikely to be readily available, and the scale and potential cost of such a project could be considerable.

4.18 High Speed 2 offers an opportunity to take new approaches. These include Automatic Train Operation (similar to the Victoria Line on the London Underground), and a fully integrated Traffic Management System which allows real-time adjustment of the timetable to recover from any disruption and automatic re-rostering of train crews. It is to be expected that other parts of the sector will take lessons from HS2, and incorporate such innovations into their own operations.

A digitally connected railway

4.19 Today, train control and command is provided through a communications-based signalling system delivered to a European-wide standard. This system relies on GSM-R, the UK railway's operational digital connectivity network, which is based on 2G cellular mobile technology and provides operational communications between drivers and signallers.

4.20 GSM-R has several limitations, not least its very low data rate capacity in the modern world of broadband wireless communications and applications. GSM-R will simply not be able to handle emerging bandwidth-demanding applications and requirements. Another limitation is that it is based on a mobile technology which manufacturers are beginning to phase out around the world, and at some point the availability of equipment will become a challenge.

4.21 Network Rail's Digital Railway Strategy[75] will address some of these issues by renewing old signalling across the network in a more affordable way. Network Rail is providing cross-industry leadership, expertise and co-ordination, with route stakeholders taking the lead on local delivery. About two-thirds of the rail network's signalling system needs to be replaced in the next 15 years, and the programme will include a number of other technologies, such as traffic management controls and Connected Driver Advisory Systems, to deliver a more dynamic and responsive railway.

4.22 This will not only help ensure the continued relevance of the railway in a future transport system, but will in parallel be likely to deliver considerable cost savings,[76] more efficient use of existing assets and an improved user experience. Benefits could include:

■ more capacity at peak times by allowing trains to run closer together;

- faster journey times by optimising the speed of trains, and reducing the need for unnecessary braking;

- reduced delays and disruption, through the implementation of monitoring technologies which 'predict and prevent' in-life failures, and which allow operators to adapt in real time to changes in network conditions;[77]

- a lower whole life cost of assets, by improving sustainability; and

- enhanced safety for passengers and workers.

Data collection and sharing

4.23 A wealth of data is collected on the railway to support the operation, maintenance, renewal and enhancement of the network, and on passenger usage. However, data collection is often for a single purpose, lacking an overall system dimension and is commonly stored in separate locations. The industry lacks data with sufficient granularity on passenger journeys, relying on census data and other surveys for information on the origin and destination of passengers' end-to-end journeys, and relying on ticket sales and surveys for station patronage numbers.

4.24 The rail sector has begun to take steps to improve data sharing. In 2012 Network Rail started to release open data feeds as part of a wider transparency commitment. This has continued to grow, and it now includes access to a number of operational data feeds such as train positioning and train scheduling data across the network. In addition to this, in 2015 RDG launched a self-sign-on Open Data portal which has led to the release of greater levels of information, supporting improvements in the consistency of information between channels through the development and maintenance of Darwin (a National Rail Information database).[78] The Joint Rail Data Action Plan[79] sets out actions for the rail industry and government to improve the quality and openness of rail data, and address barriers that inhibit it from being shared.

4.25 However, more could be done to meet future challenges. Some estimate that the consequence of not improving transport data sharing will be £15 billion in lost benefits by 2025.[80] Obstacles to more open data sharing include legacy IT, a lack of skills in the workforce to make the best use of the data that is collected, funding constraints and commercial sensitivities. There are insufficient guidelines in place to determine what data is or is not commercially sensitive, which leads to not sharing being the safest option. It will also be important to ensure that data privacy issues are addressed, and that data practices remain compliant with policy and legislation. Greater transparency is required on what data is currently collected, how it can be made available and the frameworks for how it should be used. And standards bodies are not seen as being sufficiently empowered to ensure consistent approaches, meaning that even when single data sources are available, these may be interpreted differently by different groups.

4.26 Better data collection and sharing would benefit the industry and government through providing more visibility of the time and route of travel routes, and data on larger subsets of passengers would improve demographic understanding leading to more accurate demand forecasting. A journey does not start and end at the train station, and a more detailed understanding of journey behaviours would allow rail to better integrate with connecting modes, businesses and attractions. Free flowing data underpins commercial innovation and would allow the integration of other modes and services, such as MaaS. In addition, understanding customer habits beyond the train station would help the industry to better meet the requirements of passengers, and could attract more people to rail.

5. Workforce skills

5.1 Operating a railway for the future will also require the workforce to adapt. The profile of employment in the sector is already changing, as technological innovation provides the opportunity for staff on trains and stations to provide greater focus on customer service.

5.2 Changes to how railway infrastructure is maintained and improved will also create new roles in the workforce, as there is likely to be a greater focus on remote monitoring of equipment and technologically assisted changes to ways of working on the track.

5.3 In addition to the changes in job roles, the industry needs to improve its productivity. This requirement comes from both general good practice of bearing down on costs within industry, and from the need to compete with other transport modes. Over time, automation and other improvements in technology will reduce the cost base of other transport modes. Rail will become less competitive if it cannot make similar improvements in its overall cost base, of which roughly one third is workforce costs.

5.4 A railway fit for the future also means being representative of the diversity of the community in which it operates – currently the overall workforce is largely male (87%),[81] and there is inadequate understanding of how diversity is represented across different roles within the industry, including people from black, Asian and other minority ethnic backgrounds, those with disabilities, people with flexible working arrangements or those returning from parental leave. The industry is responding to this challenge by implementing a range of initiatives which aim to make the sector more attractive to under-represented groups and create a workforce which can support the implementation of new technologies, seize opportunities from increased levels of investment, and support the Government's plan to increase productivity in the UK.

The majority of the workforce is male

13.4% Female

86.6% Male

Existing industry diversity initiatives

Network Rail's Everyone Strategy has led to practical steps within the organisation to improve gender and BAME diversity in recruitment for jobs and training, including roles that traditionally attract fewer women. Rail companies, such as Southern Railway, have also worked in partnership with The Prince's Trust to deliver the "Get into Railways" four-week training programmes, targeted at young people from under-represented backgrounds.

5.5 New skills will be required to enable staff to fully exploit the opportunities of a digital age. These skills are largely sector agnostic and demand for them is increasing across the economy, which increases the pressure of ensuring rail remains an attractive career. In addition, there are areas such as Intelligent Infrastructure where the applicability of technology will be critical. Skills increasingly needed for the future will include basic digital skills, software engineering, data analytics, systems engineering, cyber security and resilience, and diagnostics and monitoring.

Addressing the workforce skills pipeline

Due for completion in 2020, and funded as part of the newly-created UK Railway Research and Innovation Network (UKRRIN), the new School of Engineering at the University of Birmingham will sit alongside a world class centre of excellence in rail in partnership with industry, incorporating a Digital Systems Innovation Centre.[82] It will focus on railway control and simulation, data integration and cyber security, condition monitoring and sensing, and improved methods for technology introduction.

In addition, industry in conjunction with ASLEF has developed a National Driver Training Academy that will look to develop the future of driver requirements to meet industry needs. It will also improve the diversity of the profession.

High Speed 2

5.6 Fundamentally, High Speed 2 is about network capacity for the railway, increasing local services and delivering more rail freight. It is also an opportunity to deliver the changes that will be required to operate and maintain a highly automated, data-driven railway on new infrastructure. For instance, train drivers will become systems operators, interpreting and responding to information from the trains and the infrastructure to ensure the delivery of a very high-performance service while more manual driving tasks happen automatically in the background. This has already happened with success in aviation.

5.7 To equip the workforce for requirements of the future railway, HS2 Ltd has invested in the National College for High Speed Rail to develop workforce capability and produce a new generation of highly skilled professionals for the industry. Additionally, HS2 Ltd has a target to create 2,000 apprenticeship opportunities over the lifetime of the project, which will provide another route for the development of the workforce to meet the challenges of the future.

Ticket sales

5.8　Changes in the way passengers can purchase tickets indicate that the role of ticket office personnel is an opportunity to develop new ways of serving passenger needs and sustaining the demand for railways as a preferred mode of transport. The number of tickets sold at ticket offices has fallen by nearly a third since 2003/04, whereas the number of tickets sold online was 41 times greater in 2017/18 than in 2003/04. Should these trends continue, online sales will overtake those at ticket offices and by Ticket Vending Machines (TVMs) in the next couple of years.
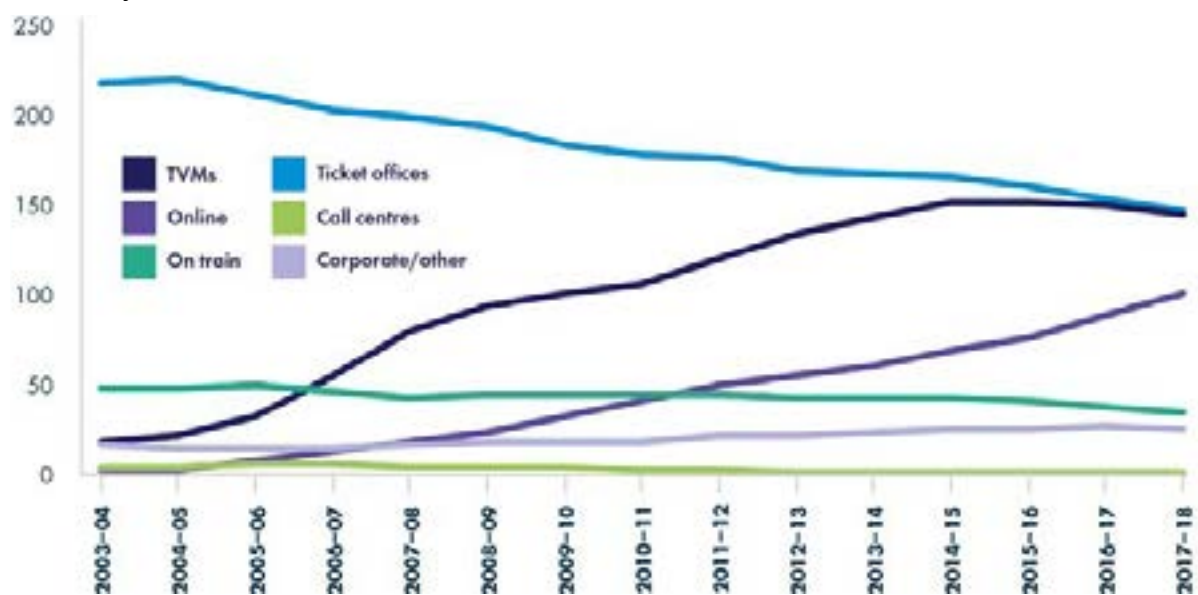

Figure 4. Tickets issued by channel (millions)[83]

5.9　This is a clear opportunity to recognise existing trends and for the workforce to upskill in new areas. This requires the industry to provide an appropriate skills and training agenda that supports staff development, as well as updating ways of working, to better deliver for passengers now and in future.

Annex: The railway in the future – possible scenarios

A.1   The role that rail will perform in the future transport system is by no means certain; the further ahead we look, the greater that uncertainty. Nevertheless, being alert to possible scenarios will help us engage with the issues and make policy decisions to shape the future railway that we want and need.

A.2   Looking ahead to 2040, key areas of uncertainty relate to the following three issues:

- **Working patterns and locations**. Work could become more fluid and commuting patterns could break down, or alternatively traditional work patterns in city centres could continue.

- **Digital integration of the rail sector.** The agility of the rail sector will be largely determined by the degree of data sharing with third parties. Rail could become a digital island, competing with other modes for transport demand, or could be integrated with other modes which complement rail services.

- **How we value public transport.** The service provision expected by passengers and taxpayers, and the values they place on transport, could change. On the one hand, public service mobility could be seen as a right, made available for all. On the other, subsidy of rail services could become increasingly selective, with reduced services focusing on the more heavily used routes between major conurbations.

A.3   These factors represent a mix of issues which are both within and beyond the sector's control. They combine fluctuations in rail demand as a result of changing lifestyle choices, as well as competition from other transport options. The three factors are by no means an exhaustive list, but the degree to which they play out will partly determine the role of rail in the future. Considering the complex interplay between these issues can help illustrate the degree of uncertainty and a range of possible outcomes for rail.

A.4   Three possible hypothetical scenarios are described below, alongside their respective implications for rail, although it should be noted that these are only indicative futures and represent a very small number of possible future states of the transport system and broader social structures.

Scenario 1: Rail innovation in a new world

A.5   In this scenario, work patterns become more fluid and the traditional 9 to 5 working day is ever more uncommon. Rail pricing has evolved in response, with prices better reflecting the use that passengers make of the network. Rail is integrated with other modes through open data sharing, and mobility is seen as a right that should be provided to all.

A.6   The social expectations of younger people as they move into work from education, coupled with the expansion of digital connectivity and associated technology, has meant that the workplace in 2040 has become a location for targeted interactions rather than every day, business as usual, activities. Trends seen in the 2010s for younger people to move to and stay in large cities have continued, encouraged by supportive housing policies to increase housing supply. As home location is less important for work, there has also been an upswing in local regional centres. In an increasingly connected world, users expect to access services independent of location and expect to be able to make efficient use of travel time. This has all led to a booming mobility service industry, providing easy and affordable door-to-door travel across a range of modes.

A.7   **Role of the railway:** The railway has capitalised on the changing market, offering new services and flexible ticketing. Train stations and trains offer workspaces and stations are hubs where workers congregate in dedicated spaces to conduct business. Given that fewer journeys are made for work purposes, initiatives in the leisure sector have become an important component of the rail offering. Digital connectivity also helps meet online shoppers' expectations of up to the minute information on the location of their goods – more data sharing across the rail industry has enabled this, and greater commercial integration has led to increased efficiency across the logistics network.

Scenario 2: Rail as the backbone of mobility services

A.8   In this scenario, traditional working practices continue with people congregating in urban centres; rail is well integrated through open data sharing with other modes, which complement rail services; and mobility is a selectively subsidised market.

A.9   We do not see the cultural shift in working practices predicted for the 2020s, as a result of people moving to smaller homes and prevailing business cultures which still encourage staff to be in the office. Most people continue to commute to work during peak hours, which fits well with family life and company practices more generally. Employment continues to be located in major cities, despite the efforts

of some smaller regions to increase local economic development. The service sector has continued to grow. Shared electric cars and minibuses, electric bikes and scooters, as well as more traditional public transport services, support easy first and last mile(s) access to rail. Self-driving or automated ride hailing services are also now starting to make a dent in the travel market. In some places, open data standards have enabled new business models in the mobility market to flourish, with many people choosing to subscribe to one of the number of major providers. These services have led to increasing public transport usage and declining car ownership, particularly in larger cities.

A.10 **Role of the railway:** Higher paid service jobs have sustained rail commuting and business demand, and rail has become the backbone of an inter- and intra-city mobility market by carrying passengers the greatest proportion of distances within their end to end journeys. Rail has integrated digitally with other modes to support user-friendly door-to-door mobility services, and shares data with other transport services to be a key component of mobility packages.

Scenario 3: The decline of rail

A.11 In this scenario, work becomes more fluid and commuting patterns break down as people increasingly work remotely or more flexible hours. Rail is a digital island, operating as a silo and unconnected with other modes, and mobility is a selectively subsidised market.

A.12 Employment has become a tale of two generations. While younger people are still attracted to cities, they have to contend with student debt and low paid, insecure employment further into their life course than previous generations. Older people, on the other hand, remain in well-paid, secure jobs for longer as the retirement age increases. Many transition into retirement over a longer period, taking advantage of flexible working practices to commute into cities less frequently. Although the impact of less generous pension provision is felt by some, this has been offset by government policies for social and health care provision. While the economy has only grown slowly in the last 20 years, the digital sector has continued to expand, as have the transport modes that embraced this technology. By 2040, self-driving or automated vehicles will be increasingly popular with these older age groups, as they can stay safe and connected.

A.13 **Role of the railway:** The railway has not kept pace with competition; its services are seen as less convenient and poorer value for money, except on the traditional commuter routes to London. Across the age divide, there is less travel by rail. Price sensitive younger people choose shared riding services

over urban rail, while older people live further from stations, travel less for work, and have switched to driving electric cars for leisure. In the short term, greater available capacity on the rail network infrastructure could lead to growth in freight usage, but in the longer term this passenger decline could have implications for affordability.

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