Deloitte.

SCOTTISH FUTURES TRUST

The economic and social impacts of enhanced digitalisation in Scotland

A Report for the Scottish Futures Trust

July 2015

Contents

Important Notice from Deloitte

This final report (the "Final Report") has been prepared by Deloitte LLP ("Deloitte") for Scottish Futures Trust ("SFT") in accordance with the contract with them dated 24th February 2015 ("the Contract") and on the basis of the scope and limitations set out below.

The Final Report has been prepared solely for the purposes of estimating the economic impacts of different scenarios of enhanced digitalisation, as set out in the Contract. It should not be used for any other purpose or in any other context, and Deloitte accepts no responsibility for its use in either regard.

The Final Report is provided exclusively for SFT's use under the terms of the Contract. No party other than SFT is entitled to rely on the Final Report for any purpose whatsoever and Deloitte accepts no responsibility or liability or duty of care to any party other than SFT in respect of the Final Report or any of its contents.

As set out in the Contract, the scope of our work has been limited by the time, information and explanations made available to us. The information contained in the Final Report has been obtained from SFT and third party sources that are clearly referenced in the appropriate sections of the Final Report. Deloitte has neither sought to corroborate this information nor to review its overall reasonableness. Further, any results from the analysis contained in the Final Report are reliant on the information available at the time of writing the Final Report and should not be relied upon in subsequent periods.

Any decision to invest, conduct business, enter or exit the markets considered in the Final Report should be made solely on independent advice and no information in the Final Report should be relied upon in any way by any third party. This Final Report and its contents do not constitute financial or other professional advice, and specific advice should be sought about your specific circumstances. To the fullest extent possible, both Deloitte and SFT disclaim any liability arising out of the use (or non-use) of the Final Report and its contents, including any action or decision taken as a result of such use (or non-use).

Foreword

The importance of digital communications and connectivity to Scotland cannot be underestimated. As the world changes, and digital capability enables more and more in everyday life, it is important that Scotland is at the forefront of this revolution, enabling the whole country to benefit. A digitally enabled Scotland also underpins the Scottish Government's core commitment to creating opportunities for all to flourish, through increasing sustainable economic growth, opportunity and equality.

In 2012, the Scottish Government published "Scotland's Digital Future – Infrastructure Action Plan". This action plan outlined its commitment to a world-class, future proofed digital infrastructure that will deliver connectivity across Scotland. The purpose of the plan is to deliver a step change in people's ability to access the internet, enabling them to connect from their homes, businesses and while on the move; essentially, any device, anytime, anywhere. A key aspect of achieving the world class vision is to create a comprehensive delivery strategy and road map for supporting investment in digital infrastructure in Scotland, for which Scottish Government has tasked Scottish Futures Trust ('SFT') to take the day to day lead in developing.

An important component of this strategy is to develop a clearer understanding of the potential impact of achieving this world class vision, and SFT has commissioned Deloitte to undertake an assessment of the potential impact of enhanced digital capability in Scotland. The study provides an assessment of the wide range of benefits that could be derived from enhanced digital provision, across a range of outcomes that include social and economic benefits, as well as other effects such as enabling increased public and private sector activity and productivity. Any future development of digital connectivity will also have a potential impact upon the delivery of existing services and products for consumers, business and the public sector, and drive the development of innovative approaches for each of these.

To enable the impact assessment to be undertaken, SFT developed a series of digital demand and use scenarios (broadly based on those produced by DCMS as part of their 2014 Infrastructure Strategy Review). These three scenarios are intended to capture different pictures of Scotland's future digital capability and usage; ranging from simply a continuation of current trends through to a transformation in usage and impact to place Scotland as a digital world leader. The impacts presented in this document are intended to illustrate what could happen in Scotland under each of the scenarios, and are not intended as forecasts of future benefit.

The impact assessment does not seek to identify the infrastructure investment that is required to enable the impact to be achieved, and to that end presumes that appropriate digital infrastructure would be in place to do so. Identification of the potential digital infrastructure deficit to meeting the needs of each scenario is not the aim of this study, and is to be addressed through other elements of the digital road map being developed by SFT.

The impact assessment provides stimulating reading, highlighting the benefits which could be captured for Scotland if there is appropriate investment and support for building Scotland's digital base. At Scottish Government and SFT, we are working in partnership to maximise such a position and the future impacts for Scotland.

Tony Rose
Director of Digital
SFT

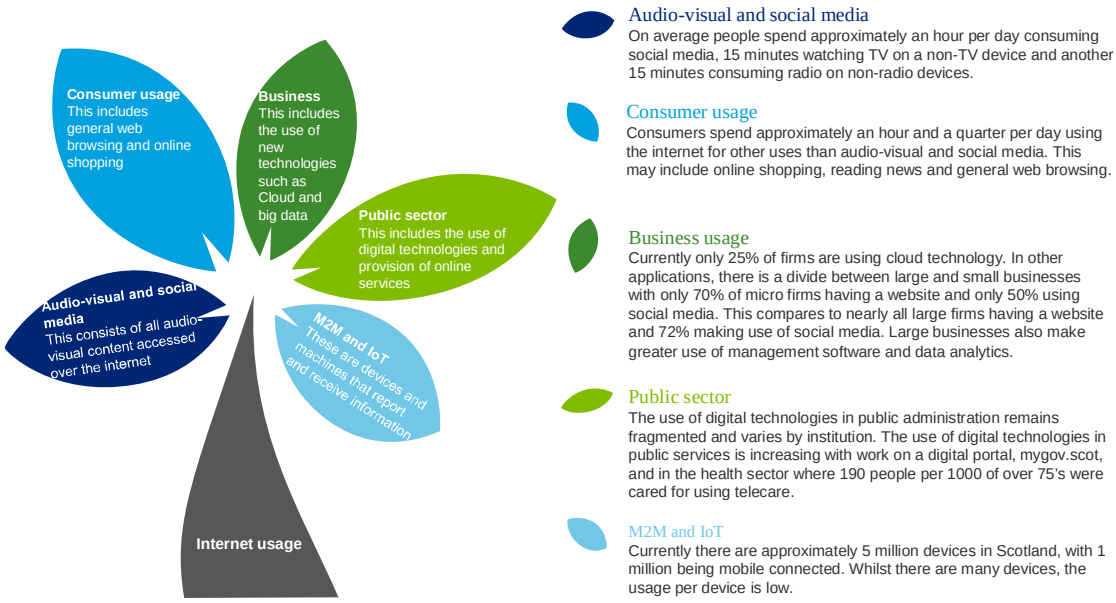
Executive Summary

Digital Scotland today

Similar to other European countries, Scotland is characterised by high penetration of digital and telecommunication services, with 83% of people having access to a fixed line and 90% having access to at least a mobile phone.[1] Access to the internet has been steadily increasing in Scotland, from 49% of households having access to the internet in 2005 to 78% now. However, this remains below the European Union (EU) average of 81% and out of those with a mobile phone, only 62% use their mobile to access the internet. A "Digital Divide" remains in Scotland whereby for example:

- Digital penetration varies across different geographic areas in Scotland. While fixed internet penetration is higher in more rural areas, usage per connection is lower, with 20% less fixed usage and 28% less mobile internet usage in remote rural areas compared to urban areas.[2]
- Internet penetration amongst businesses, at 95%, is higher than that of consumers but there remain significant differences in the speed and reliability that firms use and their use of technologies: larger firms in Scotland are more likely to use Next Generation Access (NGA) broadband and are also more likely to make use of mobile internet and mobile technologies. Of small businesses, only 17% have NGA.[3]

Figure 1: Current internet usage in Scotland



Source: Ofcom CMR 2014, Scottish Business Survey 2014, Cisco VNI forecast, and the Social Experiment survey by First Direct

Scenarios of enhanced digitalisation

The DCMS has defined three scenarios for digitalisation in the UK, which SFT adapted to fit the Scottish context. These three scenarios aim to capture three different states of digital enhancement in Scotland, whereby digitalisation becomes increasingly embedded. These scenarios assume that there is access to sufficiently fast network speeds for the demand scenarios to be achievable.

- The profiles of usage and service availability associated with these scenarios are estimated. A counterfactual scenario estimates what may happen if there are no actions to improve digitalisation and represents expected changes such as demographic change impacting penetration. These are estimated through an analysis of information and data from sources

[1] Ofcom, 2014, Communication market report: Scotland
[2] Deloitte analysis based on Ofcom and Cisco data
[3] http://www.gov.scot/Topics/Economy/digital/digitaleconomy/businesssurvey-2014

such as the Scottish Government and Ofcom, a review of international benchmarks and from market analysts and participants such as Cisco. These are not intended to be a forecast of digital penetration and usage in Scotland, but rather as a view of penetration and usage profiles that could materialise to achieve the digital outcomes indicated by SFT. Based on this estimation, the economic and social impacts that may materialise in Scotland under these scenarios are then described.

- Each scenario has been reviewed in relation to penetration, usage and impacts on Digital Divide in Scotland. A more detailed profile is then presented of services used by consumers, including audio-visual usage, by businesses, the public sector, and in relation to the Internet of Things ("IoT"), i.e. products, such as cars, which contain devices connected to the internet for the purpose of sending and receiving information.

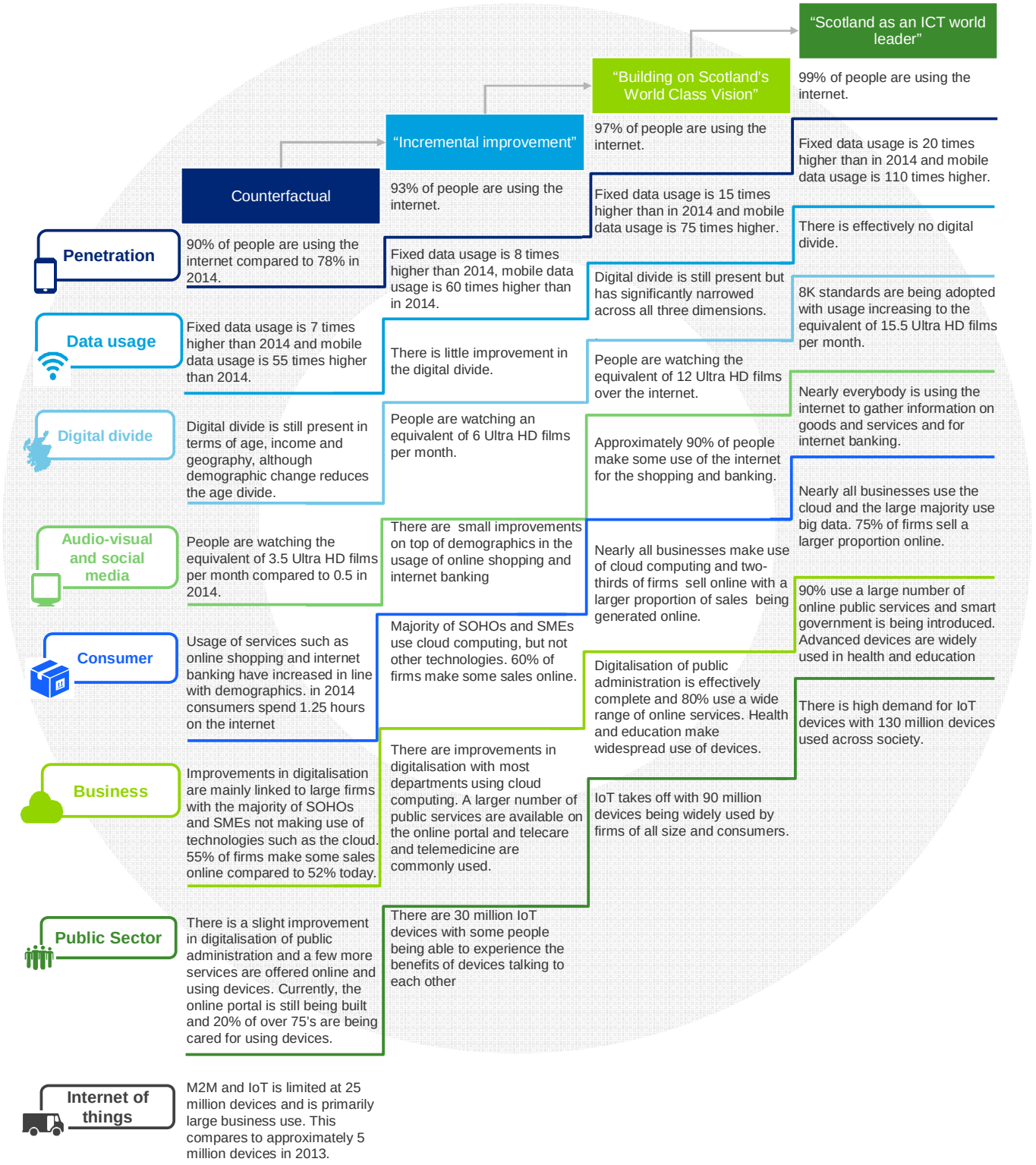
These scenarios can be summarised as follows:

- **Scenario 1: "Incremental improvement in digitalisation".** Under this scenario, penetration and usage both increase as the economy digitalises. However, this only represents a small improvement over a scenario that would see no departure from current trends (i.e. the "counterfactual" scenario) and a digital divide remains. This would result in: a 3% increase in penetration on top of the counterfactual with 93% of people using the internet, with data usage 11 times higher than in 2014, only a slight increase in audio-visual consumption, 70% of businesses using cloud computing and 30 million IoT devices, a 20% increase on the counterfactual.

- **Scenario 2: "Building on Scotland's World Class Vision".** Penetration and usage both increase significantly above the counterfactual as digitalisation spreads to most consumers and businesses, resulting in a narrow digital divide. Digital technologies are widely used, but worries about over reliance on technology constrain the widespread use of the most advanced technologies. Using this scenario profile, 97% of people would have access to the internet, using 19 times more data than in 2014; consumers would spend twice as much time compared to the counterfactual viewing audio-visual content, 85% of businesses would use cloud computing and IoT devices would amount to 90 million.

- **Scenario 3: "Scotland as an Information Communications and Technology (ICT) world leader".** Penetration and usage grow quickly as Scotland becomes a world leader in digitalisation. Consumer usage of higher definition audio-visual drives large increases in usage and digital technologies are widely used in the home, for business, across cities and for public service provision. Based on this digital profile, 99% of people have access to the internet and data usage is 26 times higher than in 2014, with 8K audio-visual standards being adopted. 95% of businesses would use cloud computing and 130 million IoT devices would be present in Scotland.

Figure 2: Enhanced digitalisation scenarios: demand profiles (incremental changes by 2030)



Source: Deloitte analysis

The economic impacts of enhanced digitalisation

Enhanced digitalisation has already changed many aspects of the lives of individuals in Scotland, from reducing isolation in remote areas to creating new ways to communicate and socialise, new business models and industries, and more efficient ways for firms and workers to operate. Innovations such as search engines, online marketplaces and social media as well as the convergence of these platforms with nearly all existing activities have permeated Scottish society and impacted productivity, economic growth and business creation. These platforms have also started to change the way in which public services, healthcare and education are provided and shared.

- Across the enhanced digitalisation scenarios, increasing levels of penetration enable greater access to information and to seamless digital experience, and while today's level of digital penetration in Scotland is high, ubiquitous penetration has important impacts on those consumers and businesses that remain excluded from internet consumption, potentially delivering significant social benefits.

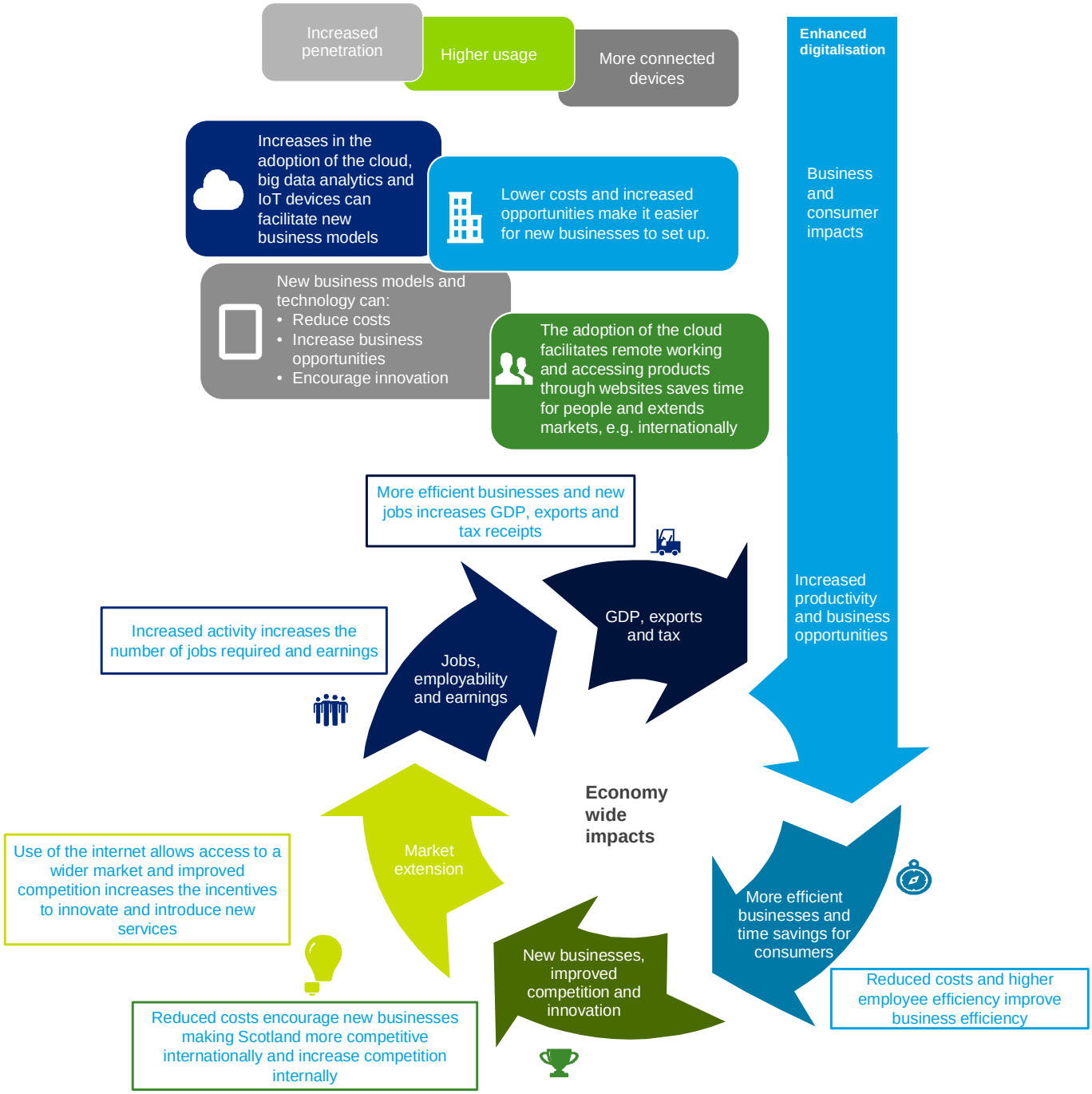
- Economic growth from digitalisation is also driven by the significant increase in digital usage, i.e. by how people and businesses use the internet. Whilst a large proportion of the data consumption is likely to consist of audio-visual usage, which may have an impact on the media sector but is mostly associated with leisure time, usage of the internet and digital technologies by businesses and the public sector also increase as Scotland becomes more digitalised.

- A key differentiator across the three digitalisation scenarios is how businesses connect to Next Generation Networks and the technologies increased digitalisation allows them to employ. The economic impacts of three main technologies are explored: cloud computing, big data analytics and the IoT. To estimate the impacts of cloud computing and big data analytics, studies focusing on the economic impacts of using these technologies were applied to each level of digitalisation.

Based on the drivers described above, the macroeconomic estimations linked to penetration increases are combined with a set of microeconomic indicators linked to new technology access by businesses, to provide a view of the economic benefits generated by increased digitalisation, as illustrated in Figure 3. In addition to the direct impacts on productivity, Gross Domestic Product (GDP), business creation, jobs and earnings, indirect impacts can include increased exports and increased tax revenue. Enhanced digitalisation can also increasingly allow for people to experience time savings from reduced commuting, through increased opportunities for remote working, and fewer trips to the shops as, for example, they make more use of online shopping. E-commerce also has benefits for consumers who can access a larger range of products, which may improve competition and quality.

The benefits from improving the links between businesses and the public sector to consumers do not just relate to the economy. As well as generating economic benefits, increasing levels of digitalisation may also have impacts on the provision of healthcare and education as well as promoting social inclusion. This is through improved access to information and services that consumers may not have previously been able to access, for example those in rural areas will now be able to access products from a wider range of stores through the internet. The social impacts of enhanced digitalisation are explored after the impacts on the economy.

Figure 3: Economic impacts of enhanced digitalisation in Scotland



Source: Deloitte analysis

These economic impacts are estimated by applying the results of empirical studies from various sources, e.g. ranging from the World Bank to the European Commission, that have sought to measure the economic impact of enhanced digitalisation, increased internet penetration, cloud technology, big data analytics and IoT devices to the scenarios of digitalisation discussed above. The results are presented as additions to a scenario that represents what would happen to Scotland should existing trends continue (the counterfactual): this assumes GDP growth of 2% per year and population growth forecasted by the Scottish Government. The results are in many instances estimated across different geographic areas for Scotland, and can be interpreted as outcomes in which different usage profiles materialise across different geographic areas (for example, the impacts of advanced digitalisation, i.e. Scenario 3, in urban areas can be compared with a scenario of lower uptake, i.e. Scenario 1, in rural areas. Unless stated otherwise, these impacts are the total incremental impact by 2030, rather than the impact in 2030, and are reported in 2014 values.

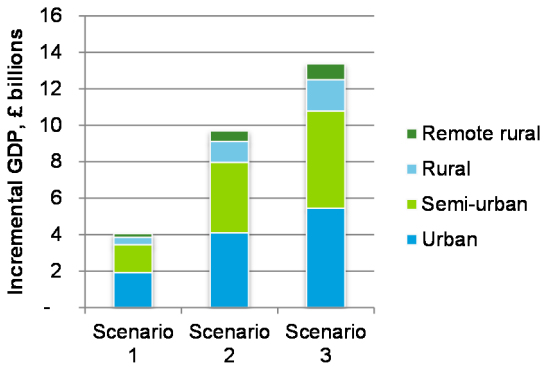
Impact on GDP

To capture the overall GDP impacts of digitalisation, results from studies measuring the relationship between increases in digital penetration and GDP and studies on the impacts of uptake of new technologies on economic growth have been used. This suggests that, if Scotland becomes a digitalisation world leader, GDP could increase by over £13bn by 2030 and by £9.5bn in a scenario of world class digitalisation compared to the counterfactual, representing a 9.8% and a 7.2% increase in GDP respectively compared to that in 2014 and cumulative increases of over £100bn and £72bn respectively. However, if Scotland only experiences an incremental improvement in digitalisation then this benefit could fall to only £4bn. On an annual basis, the penetration increase profile may lead to an average 0.5% GDP growth factor due to digitalisation in Scenario 3, with the same factor at 0.36% and 0.16% in Scenario 2 and Scenario 1 respectively.

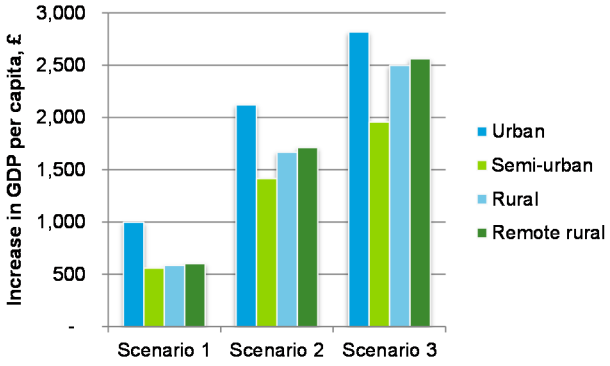
As digitalisation becomes more advanced, rural areas catch up with urban areas and an increasing proportion of the incremental economic growth is generated in in these rural regions; in the case of incremental improvement only 15% of the extra activity would be in rural areas, compared to 20% when Scotland is a world leader.

Scottish citizens could experience an increase in GDP per capita of approximately £2,500 in the scenario of world class digitalisation compared to the counterfactual. For remote rural areas this would represent a 15% increase compared to 2014 GDP per capita levels. At the household level, the average increase in GDP is estimated at over £5,000 per household by 2030. These results suggest that in a situation where rural Scotland, for example, reached world leading digitalisation, but other areas do not, then this could still result in an increase in rural GDP of £1.7bn. Similarly, if urban areas reached world class digitalisation but other areas only experience a small improvement on top of the counterfactual, then this could result in an increase in GDP of £4bn in urban areas and impacts similar to those in Scenario 1 for other areas.

Figure 4: Incremental GDP by 2030, £ billions



Incremental increase in GDP per capita by 2030

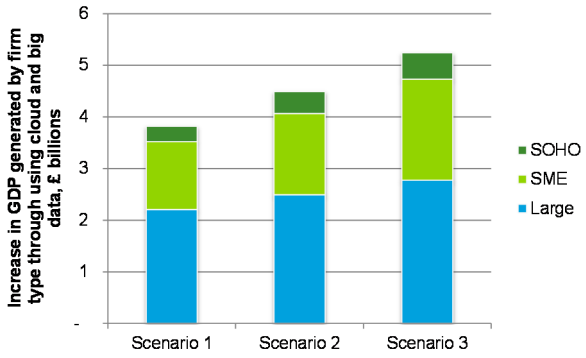


Source: Deloitte analysis

Impact on businesses

One of the drivers of the economic impacts is the adoption of new technologies by businesses and their impacts on GDP. On the basis of studies that measured the economic impacts of the cloud and big data, and considering the number of Scottish firms in each scenario that adopt these technologies, it is estimated that the economic impacts from world leading uses of cloud technology and big data could result in economic benefits of over £5bn. As digitalisation in Scotland increases across the scenarios, a greater proportion of this benefit would be generated by small office and home office firms (SOHOs) and small and medium enterprises (SMEs), up from 42% of the benefit when there is limited improvement, to 44% when digitalisation is world class and 47% when digitalisation is world leading.

Figure 5: Increase in GDP generated by firms using cloud technology and big data analytics



Source: Deloitte analysis

New businesses

On the basis of the business creation benefits of cloud computing and big data estimated by studies at the UK and EU level and the average value added of SOHOs and SMEs in Scotland, world leading digitalisation may create nearly 6,000 new SOHOs and SMEs over the fifteen year period in Scotland compared to 4,500 when digitalisation is world class.

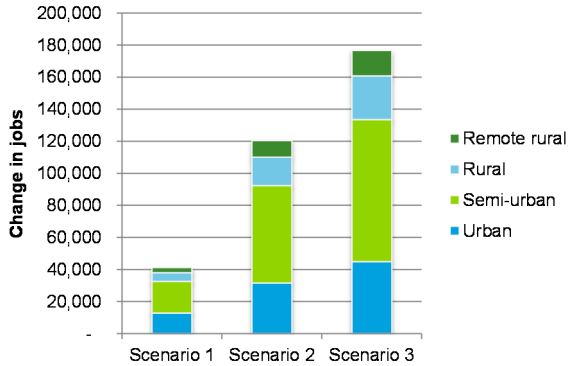
The increase in digitalisation may have a direct impact on telecommunications and ICT companies in Scotland, which in 2011 accounted for approximately 3% of Scottish value added.[4] For example, increasing levels of digitalisation may also encourage data centres to set up in Scotland, which will help improve the quality of cloud services. These can result in a significant amount of investment, for example Google has invested €225m in data centres in Dublin since 2012.[5] Other important sectors that may be affected by the adoption of new technologies are tourism, which could benefit from a wider access to information as well as better advertising; financial services, benefitting from increase connectivity and easier access to banking apps; energy and life sciences, e.g. through IoT applications such as smart meters.

Impact on jobs and labour participation

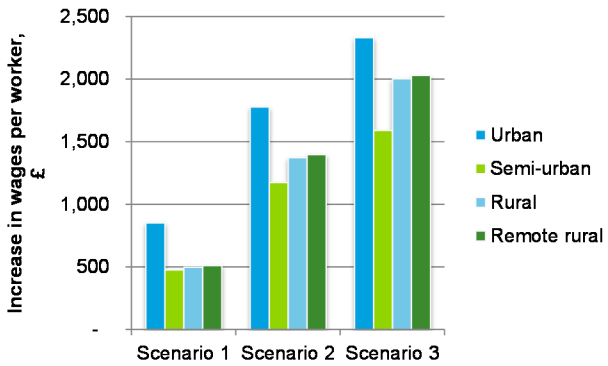
On the basis of these economic impacts, if Scotland becomes a digital world leader, increased digitalisation may generate an extra 175,000 jobs by 2030, representing an increase in those employed by 6% in 2030. This is an increase of 55,000 jobs compared to if Scotland had world class digitalisation. The increase in jobs may have a significant benefit for those between 18 and 24, for whom the unemployment rate at the end of 2014 was approximately 17.7%. The increased demand for labour, which would be more productive, also increases earnings. This increase is estimated to be up to £2,000 per worker when digitalisation is world leading and £1,400 per worker when digitalisation is world class. This represents a cumulative increase of £15,000 per worker when digitalisation is world leading and £11,000 per worker when it is world class.

While job creation is seen as one of the most important factors for reducing relative poverty, the link between poverty and digitalisation in developed economies needs to be explored more fully and is an area that could benefit from additional research.

Figure 6: Additional jobs from digitalisation



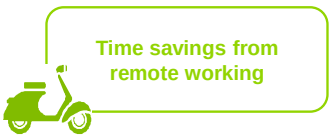
Increase in earnings



Source: Deloitte analysis

[4] 2011 Scotland Input-Output tables
[5] http://www.independent.ie/business/irish/google-to-build-new-150m-data-centre-in-dublin-30012987.html

Improved productivity and opportunities to extend the marketplace via online advertising platforms can increase the competitiveness and the attractiveness of Scottish goods and services both at home and abroad, with likely increases in the demand for Scottish goods and services. The change over time of the mix of exports is complex to predict, with Scotland's current export focusing on oil, spirits, food such as meat and fish, and financial services: based on today's export share of GDP, exports could increase by more than £2.5bn in an advanced digitalisation scenario and by £2.1bn in a scenario of world class digitalisation compared to the counterfactual. This would represent cumulative increases of nearly £22bn and £16bn respectively.



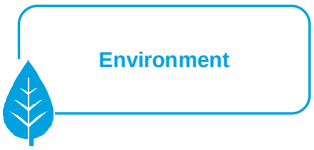
In addition to generating employment, enhanced digitalisation through teleworking can create significant time savings for those with an existing job. These time savings allow employees to reallocate that time to other activities, part of which can generate additional economic impact. Data on the average commute time, the value of one hour of commuting time estimated by the Department of Transport and the relative commute times between urban and rural areas can be used to estimate the economic value of remote working.[6] If 20% of employees in Scotland work remotely two days a week, then this could generate a value of £325m every year, with a third of this being in rural areas (despite only 20% of the population living there).

As businesses become more digitalised, selling to customers online also enables a more effective method of communicating with customers. Online advertising can be more effective than traditional advertising whilst still having positive impacts on in-store sales and online sales. One of the main reasons for the increased effectiveness is that it easier to tailor the advert to the person through collecting data on their search preferences. E-commerce may also allow firms to tailor their products to consumers as well as opening up new delivery methods.

In the same way that cloud computing can reduce ICT costs for businesses, cloud computing can reduce costs for government departments and agencies. For example, a report looking at the implementation of cloud technology in US government departments and agencies found that it reduced IT related expenditure by 25%-50%.[7] That report finds that using cloud computing can save the public sector money through achieving a higher utilisation of data centres, resulting in fewer servers being used, and increased infrastructure flexibility, which can allow the usage to be scaled up or down depending on the level of traffic.

Smart City initiatives can also improve the efficiency of public services. Across the scenarios of digitalisation, the government and other agencies are expected to increasingly use a large number of internet connected devices in order to, for example, share information on traffic, parking spaces, reduce energy use through smart metering, and improve water and waste management. As well as improving the provision of public services, smart city applications can improve the environment in which people live. These devices also generate a large amount of data. Opening up some of this data to interested parties can encourage innovation, better services and new businesses.

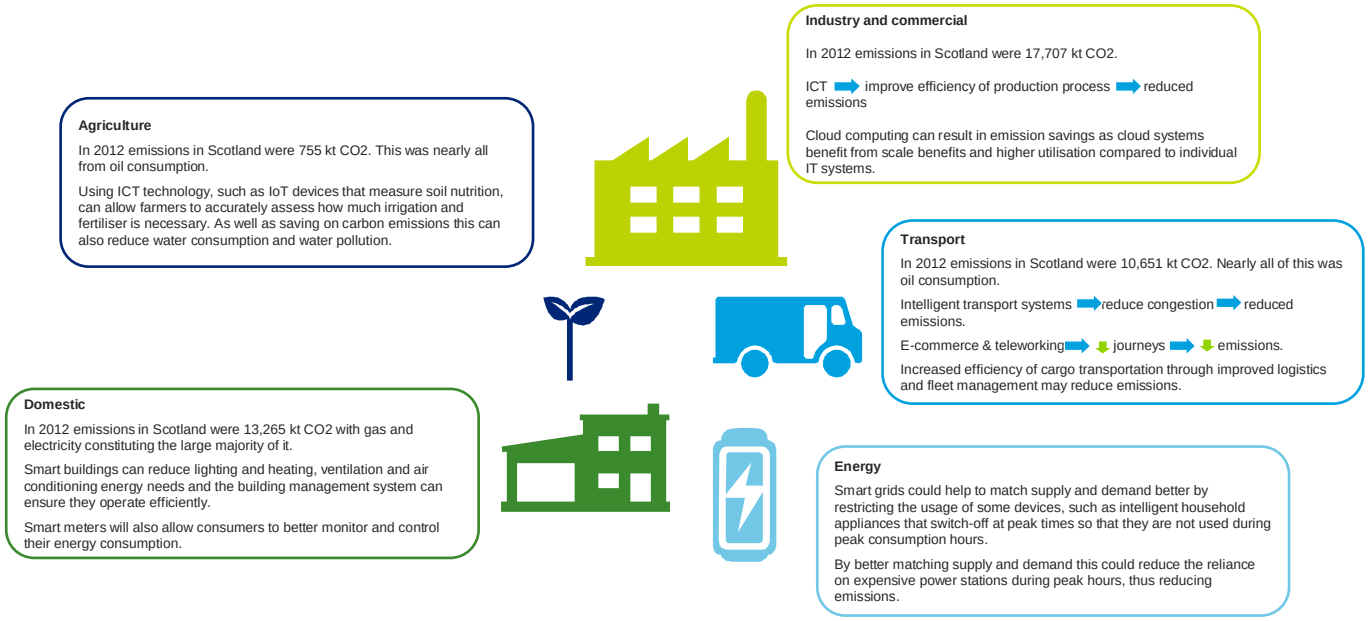
Ultimately, these benefits will have a positive impact on Scottish consumers, resulting in higher income to spend on goods and services, which they will have improved access to through increased use of digital services such as e-commerce, as well as increased choice. Using e-commerce can also save consumers time through reduced travelling, thus allowing them to use that time for other activities. Enhanced digitalisation can also facilitate innovation which can result in new products, some of which may reduce consumers' outgoings: for example smart meters can allow households to reduce energy consumption.



A key facet of more efficient and productive economic activities driven by enhanced digitalisation is given by the environmental impacts of new digital technologies and their widespread usage.

[6] Department for Transport WebTag databook Nov 2014, Labour force survey (2012) and ONS data on commuting time.
[7] Darrel West, 2010, Saving Money through Cloud computing

Figure 7: Environmental benefits of enhanced digitalisation



Source: Ricardo-AEA, "Local and Regional CO2 Emissions estimates for 2005-2012" and GESI Smarter 2020

Displacement effects

ICT and digitalisation can have a significant impact on traditional business models and supply chains, and boost the productivity of workers. This can transform markets and the way in which companies and consumers connect, with the potential to alter the competitive landscape in an industry. Examples of markets that have been transformed by digitalisation include the media industry through the online distribution of content and the retail sector, which has faced increased competition from online retailers. While many businesses capitalise on the opportunities afforded by the enhanced digitalisation, some of this benefit can come at the expense of other players in the market. Intermediaries such as high street insurance brokers and travel agents have also faced changes to the markets they operate in due to price comparison websites and consumers being able to go direct to the suppliers' websites.

In addition to the impact on businesses, digitalisation can have an impact on jobs through improved productivity, reducing the number of employees required to deliver a service. According to the industry literature, the balance between the job losses due to improved productivity and the increased business opportunities and innovation created through enhanced digitalisation is likely to result in a net gain in jobs. Recently, a study undertaken in France finds that over the past 15 years, the internet created 2.4 jobs for every 1 job that it destroyed in the French economy.[8]

As Scotland becomes increasingly digitalised over time, a transformation of economic activities is to be expected, which would be greater under a full digitalisation scenario. While this may lead to adjustments in certain activities and jobs, the transformational potential and the benefits delivered to consumers are likely to be higher than the losses associated with it. Additionally, key to considering these impacts is also the implied costs that Scotland could face if digitalisation is not fully exploited: this could include a loss in competitiveness with more efficient foreign companies and economies, with long term potential for disruption.

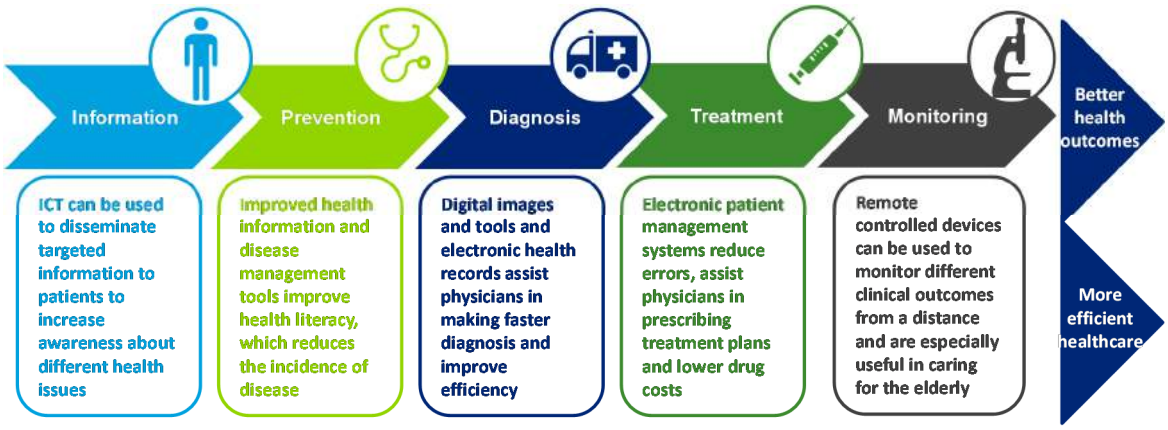
The social impacts of enhanced digitalisation

From improving the provision of services, such as healthcare and education, to enhancing social mobility and increasing civic participation, the internet has already transformed society. Enhanced digitalisation in the future has the potential to scale these improvements to a larger population. At the same time, increasing digitalisation can create new services across a series of social activities.

[8] Internet matters, McKinsey Global Institute

Digitalisation is increasingly being deployed in the provision of healthcare and has the potential to impact all segments of the healthcare service chain. Access to the internet can improve health conditions by reducing the incidence of diseases through better information for both patients and health practitioners. In addition to extending access to medical information, mobile and internet technologies have the potential to improve medical behaviours for patients and healthcare professionals by releasing doctors' time through reduced travel and increased efficiency, reminding individuals of their due treatments or medications, and providing easy access to information and enabling connectedness between patients and doctors, and between doctors in different locations.

Figure 8: Impacts of eHealth across the healthcare service chain



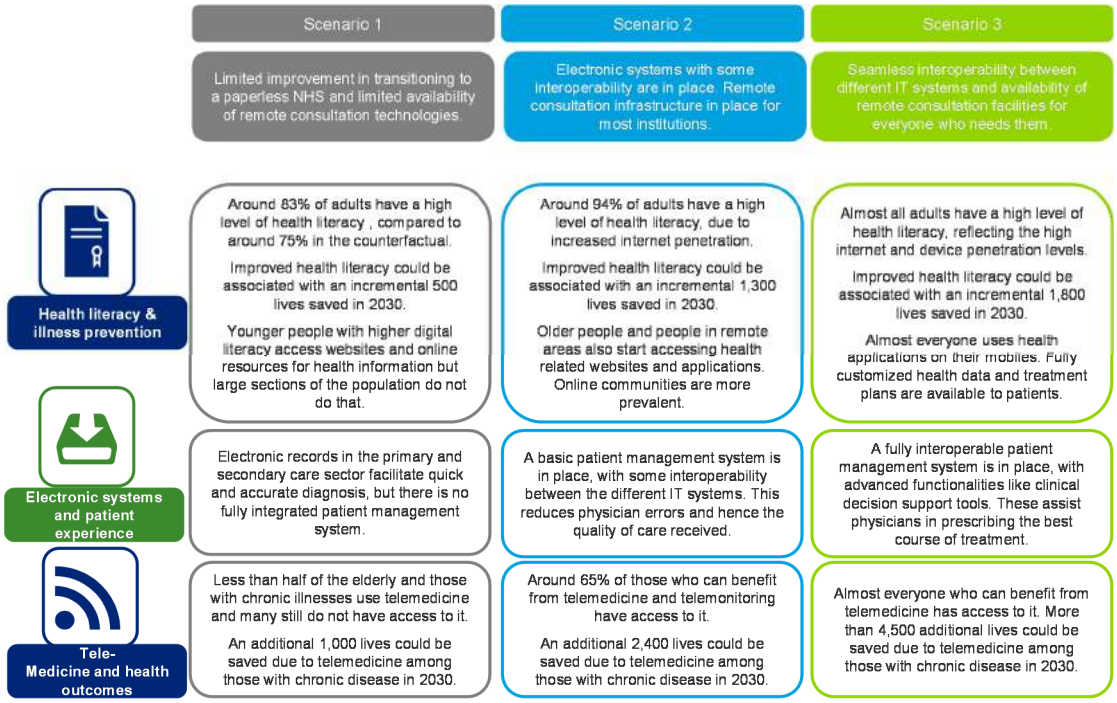
Source: Deloitte analysis

- EHealth can lead to improved health outcomes such as reduced mortality, fewer hospital admissions and a more health aware society.
- EHealth can also lead to a variety of cost savings, from reducing laboratory test costs to saving time by automating many processes, and hence improve efficiency.
- A number of industry and academic studies have considered the impacts of eHealth on health outcomes and cost savings in healthcare. These impacts have been applied to scenarios of enhanced digitalisation.

The relationship between health outcomes and the three digitalisation scenarios has been examined in relation to health literacy and prevention; how electronic systems link to patient experience, and the success of Telemedicine; the use of Telemedicine is currently limited, with only 100,000 people having access to these services.[9] By applying a number of studies focusing on the link between improved health literacy and use of telemedicine on mortality to data on population digital penetration and usage in the scenarios, the number of lives saved per year by 2030 has been estimated.[10]

[9] Reshaping Care for Older People Audit 2014
[10] More details on the studies can be found in the main report and the appendix

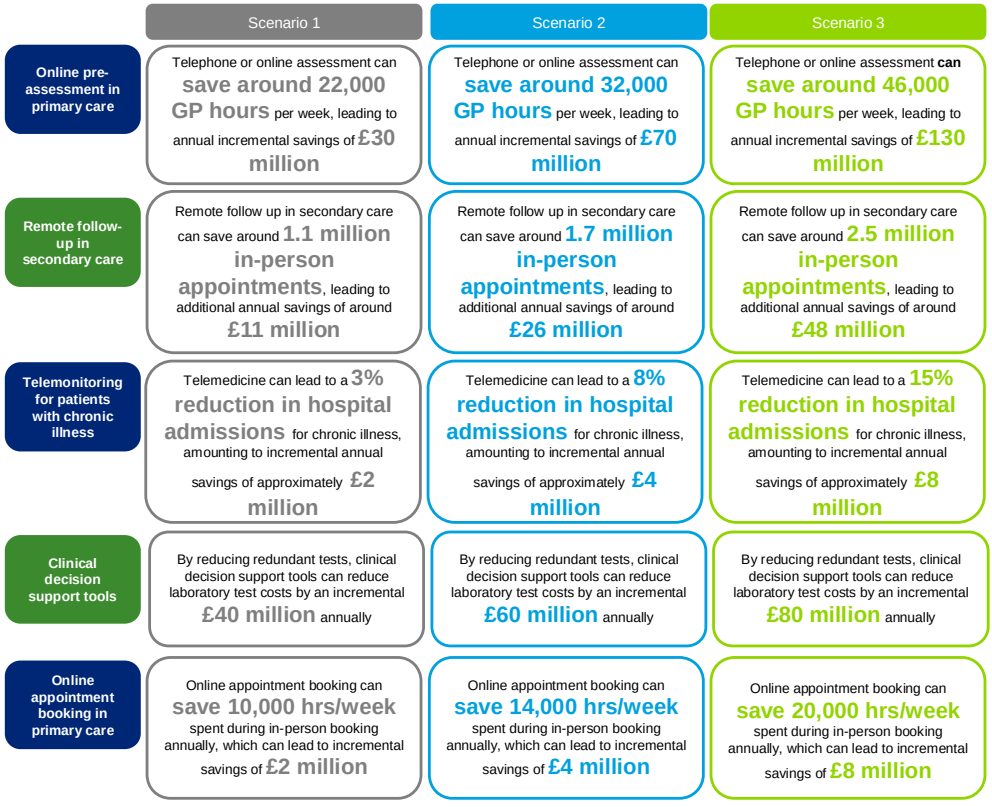
Figure 9: Impact of digitalisation on health outcomes



Source: Deloitte analysis

Health expenditure currently represents roughly one-third of all expenditure by the Scottish Government. Increased digitalisation can enable a variety of cost savings to materialise across the health sector. By applying the results of a set of studies on the impacts of digitalisation on healthcare costs to the development of different health activities, such as GP appointments and hospital admissions, to the digitalisation scenarios, a selection of cost savings for different levels of digitalisation in Scotland by 2030 have been estimated and are presented in Figure 10.

Figure 10: Cost saving impacts of enhanced digitalisation in healthcare



Source: Deloitte analysis

Impact of enhanced digitalisation on education

Increased use of the internet and communication technologies can play a pivotal role in extending access to educational resources and in accelerating knowledge sharing.

- Information technology can be used to supplement traditional learning in classrooms. Graphics, simulations and presentations can be useful to clarify abstract concepts and can enhance understanding in the classroom. In a scenario of enhanced digitalisation, customised learning tools can also be expected to be more prevalent in Scotland. These adjust learning and assessment material to the skill level of the user and hence can be extremely effective learning tools.
- Information technology can make education resources more easily and widely accessible by all, including those in more remote or less privileged areas.

An OECD review of the quality and equity of education in Scotland highlights some disparities in education access and outcomes in Scotland.[11] One of these is the link between deprivation and student attainment: over 40% of pupils living in the most deprived 5% of Scotland are in the lower attaining 20% group, compared with only 4% of the pupils living in the least deprived areas of Scotland. Another is differential access to schools in urban and rural areas: at primary school level 85% of pupils have a local authority school within three miles of their home but at secondary school level this drops to just over 40%, with much of the fall attributable to rural areas. Mobile learning programs, online courses and virtual colleges can help in bridging these inequities in education in Scotland.

The implications of enhanced digitalisation scenarios on access to education, quality of education and equity of education in schools, colleges and universities are presented in Figure 11.

Figure 11: Scenarios of enhanced digitalisation in education

	Scenario 1	Scenario 2	Scenario 3
Access to education	Traditional ways of accessing education materials are still the norm (textbooks, in-person lectures). Some students supplement learning online.	A majority of Scottish students are accessing education materials online, including video lectures, ebooks and interactive learning tools. However, some students still do not have the same level of access as others.	Almost every student has and uses a personal device and the internet for learning – this means everyone has access to learning materials anywhere and anytime.
Quality of education	Most schools use some IT in the delivery of education, such as presentations. The use of interactive white boards is also more common. This helps to engage students and makes abstract concepts clearer.	Almost all schools supplement learning with presentations and online tools. The majority of students also have their own device using which they can continuously engage with their assignments.	There is one student to one device (1:1) so that continuous learning is the norm. Customised learning tools are also prevalent, which adjust to the skill level of the user.
Equity in education	Lower levels of mobile and internet use for education mean that ICT has limited use in bridging education inequities. However, some mobile learning programs to educate hard-to-reach pupils are in place.	ICT is more widely adopted to bridge education inequities – this is done through mobile learning and other distance learning programs. Some virtual colleges also exist.	ICT is widely used to bridge education inequities in the primary, secondary and tertiary sector. Many virtual colleges help to keep the numbers of young people not in education, employment or training low.

Source: Deloitte analysis

Currently there is not a significant body of research focusing on quantifying the impacts of enhanced digitalisation in education provision at a national level. This is an area that could benefit from additional research.

Social impacts of enhanced digitalisation and digital participation

Digital participation is the capacity of all groups in society to use and benefit from this increased digitalisation. In particular, it means that certain groups such as the elderly, those from more deprived socio-economic classes and those living in more remote areas all have the capacity and skills to fully engage with the internet.

Digital exclusion in Scotland today occurs along a number of dimensions, primarily age, socio-economic deprivation and geography. The Scottish Household Survey shows that internet use among those aged 60 and above in Scotland is less than

[11] OECD review of quality and equity in education outcomes in Scotland

half of the population average use. Area deprivation is also associated with low levels of internet access – households in the least deprived communities are more than twice as likely to have internet access compared to those in the most deprived areas. Digital exclusion along geographical lines is more nuanced. The proportion of Scottish households with internet access does not differ significantly across urban and rural areas in Scotland but there is evidence that households in rural areas are less likely to have high speed broadband access compared to those in urban areas.

Narrowing the digital divide across scenarios of enhanced digitalisation along these dimensions in Scotland is likely to have a wide range of positive social impacts. It helps marginalised groups in society become more active participants in political and social life. As the delivery of public services shifts online, enhanced digitalisation helps them to access public services and improves civic participation.

Figure 12: Areas of digital participation impacted by enhanced digitalisation

Source: Deloitte analysis

In a scenario where Scotland is a world leader in digitalisation and the digital divide has been bridged, the economically deprived are likely to be more employable. People with access to the internet are better positioned to search for a job and also have access to a lot more information on the labour market. Surveys show that these people feel more socially included in modern society and less lonely. Furthermore, greater use of the internet can reduce their cost of living by providing better access to information on goods and services and by enabling online transactions.

1 Introduction

1.1 Purpose of the study

Against this background, SFT has commissioned Deloitte to undertake an assessment of the potential economic and social impacts of enhanced digital capability on a demand and user basis in Scotland. In line with the action plan discussed above, this assessment is undertaken in relation to three outcome-based scenarios on how digital capability may evolve in Scotland over the next fifteen years. These scenarios have been defined by SFT and analysis undertaken by Department of Culture Media and Sport (DCMS).[12] These scenarios do not consider the supply side requirements, such as network availability and capacity, which would be needed to support the demand profiles, or the specific products and services which users can purchase.

On the basis of these digital outcomes scenarios, this study:

- Discusses digital penetration and usage levels that may be linked to these outcome-based scenarios. These are not intended to be a forecast of digital penetration and usage in Scotland, but rather as a view of penetration and usage profiles that could materialise to achieve the digital outcomes indicated by SFT.
- Describes the economic and social impacts that may materialise in Scotland under these scenarios and reviews potential displacement effects associated with digital enhancement.
- Provides a series of case studies to supplement the analysis.

This is intended to inform the extent and rationale for any further Scottish Government and wider public service intervention in the sector, as well as inform industry and wider stakeholder groups of the potential impact of improved digital connectivity. It is not intended to apply or inform any policy or funding proposal and the analysis has not been undertaken in relation to any specific plans.

1.2 Background and introduction to SFT

In January 2012 the Scottish Government published an action plan, "Scotland's Digital Future – Infrastructure Action Plan"[13], outlining a commitment to a "world-class, future proofed infrastructure that will deliver digital connectivity across the whole of Scotland by 2020". The purpose of this plan is to deliver a change in people's ability to access the internet and digital technologies, enabling people to connect from their homes, businesses and while on the move. This underpins a vision for Scotland to become a world-class digital nation where people living, working and visiting Scotland can communicate and connect instantly using any device, anywhere, anytime.

The next stage of the development of the Scottish digital ambition is to translate this vision into a comprehensive delivery strategy. This strategy will include the development of a digital infrastructure plan and delivery programme, and an assessment of the potential economic and social impact that such a delivery programme could generate.

1.3 Approach

The approach undertaken to identify and examine the digital uptake scenarios, the economic and social impacts analysis and the qualitative assessment has been informed by:

- A review of the current digital landscape in Scotland, as evidenced by market analysts, local government and Ofcom data and reports.

[12] DCMS, 2014, Digital Communications Infrastructure Strategy: Consultation document. More details on these scenarios are included in Appendix A.
[13] http://www.gov.scot/Publications/2012/01/1487

- A set of forecasts on digital penetration, device availability and usage and technology developments from market analyst reports and discussions with market experts.
- A review of international examples and practices on digital technology developments and usage; and on usage of digital technologies in the public sector on healthcare, education and other government services.
- A series of benchmarks based on previous economic studies undertaken by Deloitte as well as academic and business literature benchmarks on the impacts of enhanced digital technologies. These impacts are then applied to the digital uptake scenarios to derive estimates of economic impacts for Scotland under each scenario. Where appropriate, impacts are provided by region and business size.
- Interviews undertaken with SFT personnel and members of public sector bodies in Scotland dealing with digitalisation and connectivity.

More details on methodologies and sources employed are reported in the rest of the paper and in the appendices.

Figure 13: Approach overview

Source: Deloitte

1.4 Structure of the report

- Section 2 describes the penetration and usage levels that could materialise in Scotland under each outcome-based scenario. Each digital uptake scenario is described with reference to penetration, usage, device and service type; as well as usage profile by consumer type (e.g. households, large, medium and small businesses), by geography (e.g. urban and rural).
- Section 3 provides an estimate of economic impacts that would materialise in Scotland under each outcome based scenario, including economic effects on Gross Domestic Product (GDP), productivity, employment, business creation, and poverty. It also discusses how next generation ICT-enabled technologies that are evolving in the markets, including cloud-based services, big data application, smart cities, as well as Machine To Machine (M2M) and IoT enabled applications, affect business performance. It also reviews examples of instances in which digital activities may disrupt existing activities.
- Section 4 examines social impacts of digital enhancement scenarios: on healthcare outcomes such as illness prevention, health literacy, life expectancy; on education access and quality; and on digital participation, i.e. the participation of individuals and groups in society's political, economic and societal processes.

Appendix A provides more details on the outcome based scenarios provided by SFT and on the data used and estimation of the digital penetration and usage levels that these outcome-based scenarios may generate. Appendix B provides the methodology upon which the analysis is based.

2 Digital outcome scenarios in Scotland

This section provides an overview of Scotland's digital landscape today, and introduces the digital outcome scenarios provided by SFT, upon which the assessment of the economic and social impacts described in the next sections is based. For each scenario, a set of digital penetration and usage profiles associated with different services and user groups is provided along with a description of the key usage patterns considered.

Due to different levels of use across Scotland's geographies and users, the scenarios and impacts consider a number of segmentations. Four geographic areas, as defined by the Scottish Government, are used: urban areas (over 125,000 people); semi-urban/small towns (between 3,000 and 124,999 people); accessible rural (less than 3,000 people and within a 30 minute drive of a town of more than 10,000 people); and remote rural (areas with less than 3,000 people and over 30 minutes from a town of 10,000 or more).[14] Five user types are also considered: consumers; large companies (employing over 250 people); small-medium enterprises (SMEs, firms employing between 10 and 249 people); small office/home office (SOHO, firms employing up to 9 people); and public sector users. Other segmentations, e.g. based on incomes and age, are also introduced where appropriate.

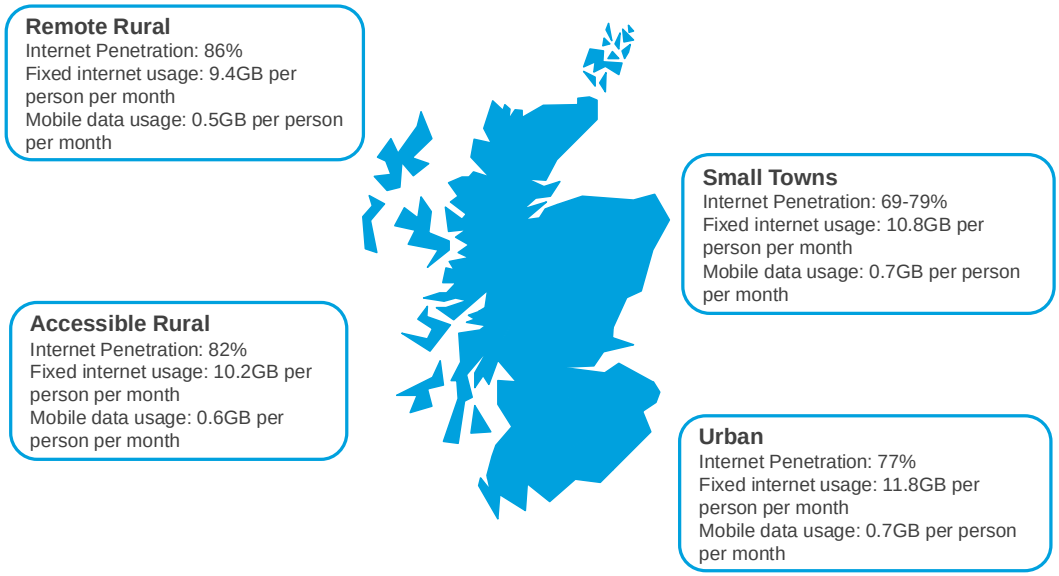
2.1 Digital Scotland today

Similarly to other European countries, Scotland is characterised by high penetration of digital and telecommunication services, with 83% of people having access to a fixed line and 90% having access to at least a mobile phone.[15] Access to the internet has been steadily increasing in Scotland, from 49% of households having access to the internet in 2005 to 78% now.[16] However, this remains below the EU average of 81% and, out of those with a mobile phone, only 62% use their mobile to access the internet.[17]

Digital penetration varies across different geographic areas in Scotland. While fixed internet penetration is higher in more rural areas, usage per connection is lower, with 20% less fixed usage and 28% less mobile internet usage in remote rural areas compared to urban areas: this is expected to be due to the reduced availability of fast internet. In comparison, only 49% of people in rural areas use their mobile to access the internet compared to 58% in urban areas.

[14] These use the six-type geographical definition used by the Scottish Government.
[15] Ofcom, 2014, Communication market report: Scotland
[16] This is defined as the number of households or access internet through a fixed connection, mobile connection or both
[17] Eurostat - Community survey on ICT usage in Households and by Individuals. Please note that in comparing the proportion of households with internet access, the data comes from two different sources using a different base; Ofcom use households including anyone over the age of 16 whereas the EU figure refers to households containing at least one member who is between 16 and 74.

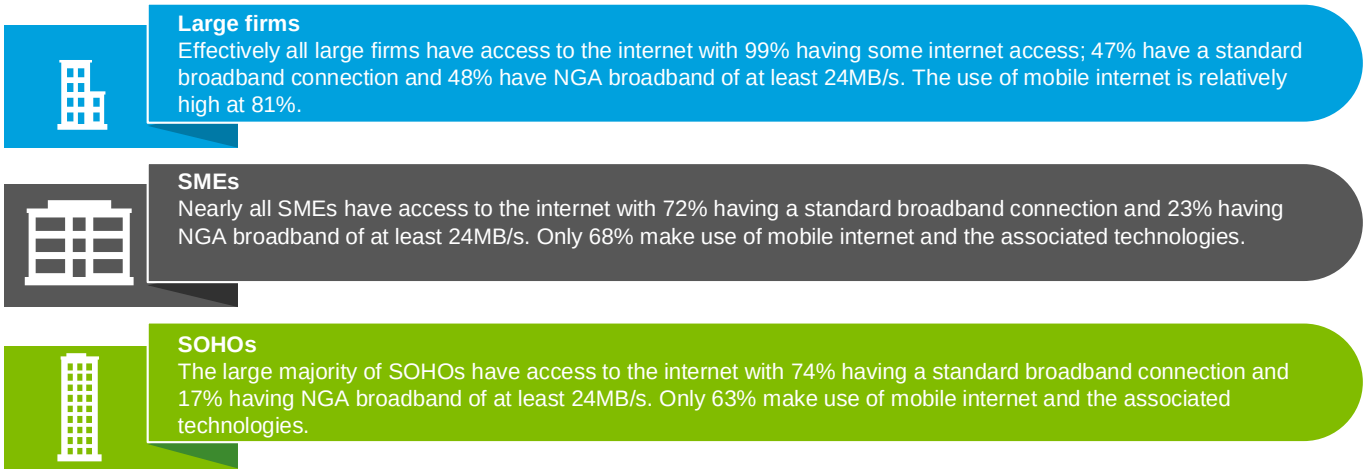
Figure 14: Geographic household internet and mobile penetration and usage, 2013



Source: Scottish Household Survey and Deloitte analysis based on Ofcom and Cisco data

In addition, whilst internet penetration amongst businesses, at 95%, is higher than that of consumers, there are significant differences in the speed that firms use and their use of technologies. According to the Scottish Digital Economy Business Survey 2014, larger firms in Scotland are more likely to use Next Generation Access (NGA) broadband and are also more likely to make use of mobile internet and mobile technologies.[18] Of small businesses, only 17% have NGA internet. Currently 25% of Scottish firms use cloud computing, although this is lower for firms in rural areas, and 34% of firms make at least some use of data analytics, rising to 75% of larger firms.

Figure 15: Business internet penetration



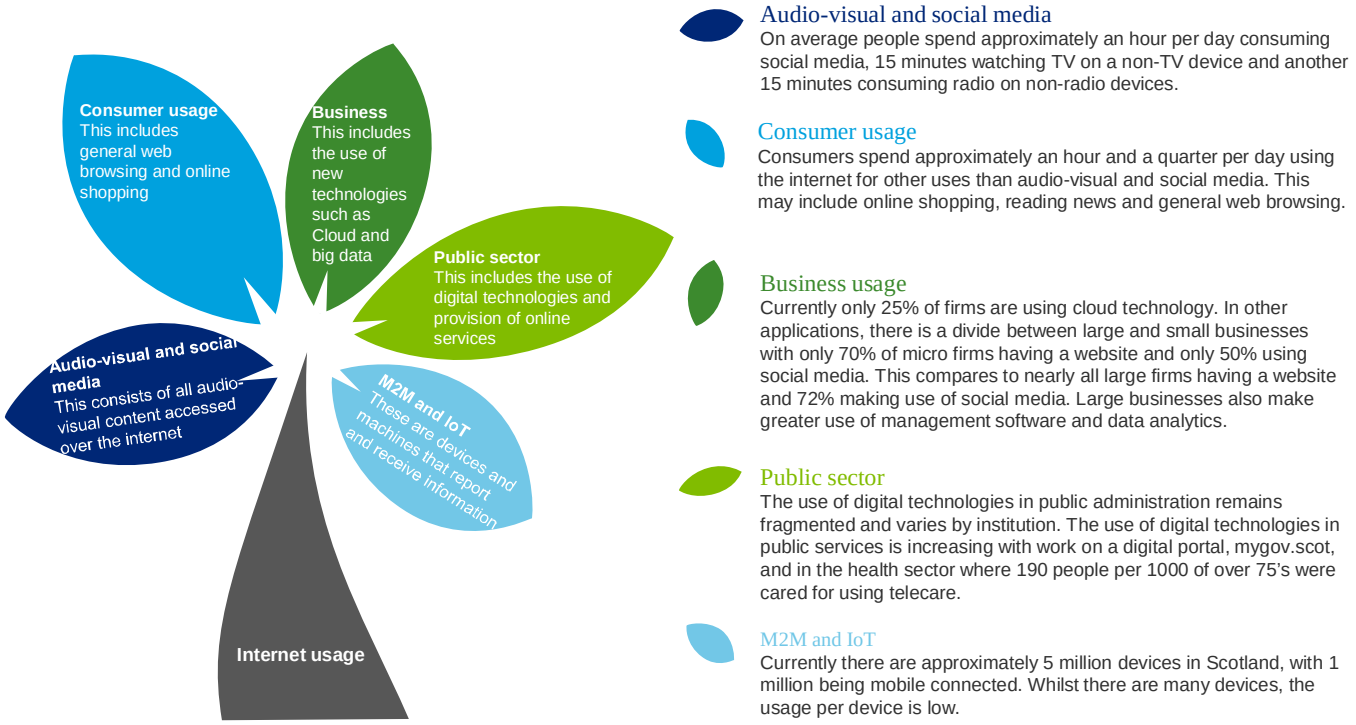
Source: Digital Economy Business Survey 2014. Difference between total and the sum of standard and NGA broadband are firms using a non-broadband connection or not using the internet.

Today's usage of digital services covers numerous areas, which have been grouped into five service types: consumer usage, audio-visual and social media usage, business usage, public sector usage, and IoT/M2M usage. Currently, consumers spend two and three quarter hours per day on the internet either on social media, news websites, online shopping and consuming audio-visual compared to four and a half hours watching TV.[19] Audio-visual usage varies significantly by age, with younger generations consuming what is regarded as traditional TV content (e.g. the news) online, often in shorter videos. Business and public sector usage is partly driven by the adoption of digital technologies. Whilst this is generally higher for large businesses,

[18] http://www.gov.scot/Topics/Economy/digital/digitaleconomy/businesssurvey-2014
[19] Ofcom CMR 2014

smaller businesses and the public sector are lagging behind. Technologies such as M2M and IoT, with 5 million devices, remain underdeveloped.

Figure 16: Current internet and digital technology usage in Scotland

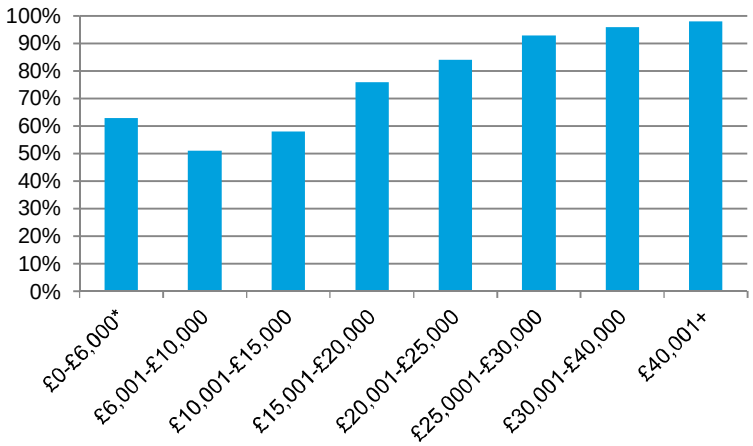


Source: Ofcom CMR 2014, Scottish Business Survey 2014, Cisco VNI forecast, and the Social Experiment survey by First Direct

Despite the increasing number of connections and digital usage, a "digital divide" remains in Scotland whereby certain sections of the population remain unconnected. A digital divide is present across three areas:

1. **Income:** Households with a lower income are significantly less likely to have internet access in the home. For example, only half of households earning between £6,000 and £15,000 per year have the internet compared to 98% of households earning £40,000 per year.[20] The Scottish Index of Multiple Deprivation shows that 64% of the 15% most deprived households have internet access compared to 81% for the rest of Scottish households.

Figure 17: Percentage of households with internet by net annual household income



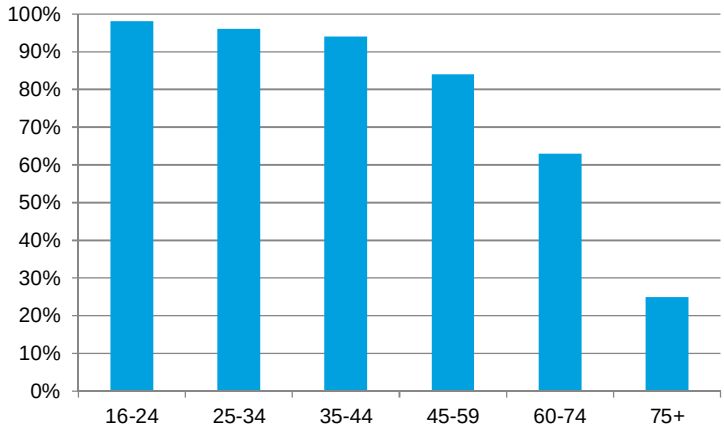
Source: Scottish household survey 2013

**Note: category £0-£6,000 only has 90 observations which may explain why the penetration is higher in this group.*

[20] Scottish Household survey 2013

2. **Age:** The proportion of elderly people using the internet is substantially lower than for younger age groups; only 25% of people over 75 uses the internet compared to over 94% for people aged under 45, rising to 98% of 16 to 24 year olds.[21]

Figure 18: Use of internet by age



Source: Scottish household survey 2013

3. **Geography:** Whilst rural areas may have a higher proportion of people using the internet, a digital divide exists in the coverage and speeds of the internet that they are able to access. This is highlighted by Edinburgh having superfast broadband availability of 87% in 2013 whereas the highlands had an availability of 3.6% and an average speed that is a third of that in Edinburgh.[22]

2.1.1 Scotland's World Class Vision[23]

Against the digital background discussed above, the Scottish Government has prepared a plan to achieve "world class digital infrastructure across Scotland". It aims to see a change in digital connectivity and communications so that they pervade every aspect of life and business across Scotland, whilst recognising that more needs to be done to deliver world class digital infrastructure. It has begun to implement this process with the Step Change Programme.

This plan spans a number of dimensions:

- **Consumers** should be able to communicate at anytime and anywhere, by accessing an electronic device, without worrying about slow download speeds or limits to downloading content.
- **Businesses** are always connected nationally and internationally and e-commerce is the norm. Businesses utilise rapidly evolving systems that take advantage of instant data to deliver innovation, greater efficiency and better support across all sectors of society.
- **Education, health care and transport** sectors are transformed through the adoption of new technologies and ubiquitous access. Healthcare centres are all interconnected allowing for fast and effective patient management during emergencies and routine health check-ups. Educationalists develop innovative programs that allow lifelong learning. Transport systems are faster, more environmentally friendly and easily accessible by the public.
- **Consumers** are able to consume high definition audio-visual content and smart TVs and internet connected game consoles are prevalent in households.
- **Public service procurement** is digital, efficient and timely. Public sector agencies have supported small and medium sized businesses to transform their market model of engagement and developed innovative, new business models to reach an itinerant, global customer base.

This vision of a digital Scotland and the approach taken in the vision provide the basis for the demand side analysis commissioned by SFT, which focuses on the socio-economic impacts of different visions rather than a supply side investment plan; we understand this will form a further piece of work.

[21] Scottish Household survey 2013
[22] Ofcom, UK broadband speed report 2013
[23] http://www.gov.scot/Topics/Economy/digital/Digital-Dialogue/ExploringDigitalDialogue

2.2 Scenarios of digital enhancement

The UK DCMS has defined three scenarios for digitalisation in the UK,[24] which SFT adapted to fit the Scottish context (see Appendix A for more details). The three scenarios developed by SFT are based on the DCMS analysis and aim to capture three different states of digital enhancement in Scotland, whereby digitalisation becomes increasingly embedded across these scenarios.[25] These scenarios can be summarised as follows:

- **Scenario 1: "Incremental improvement in digitalisation"**

Under this scenario, penetration and usage both increase as the economy digitalises. However, this only represents a small improvement over a scenario that would see no departure from current trends (i.e. the "counterfactual" scenario) and a digital divide remains.

- **Scenario 2: Scotland as a World Class digital country**

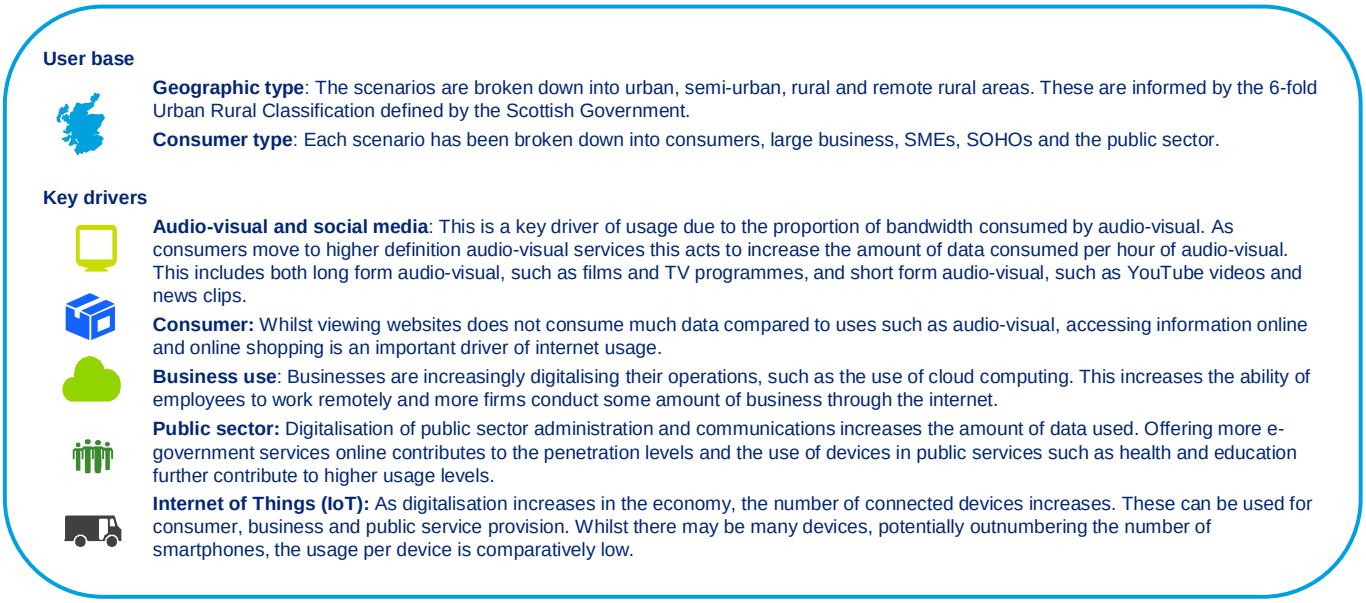
Penetration and usage both increase significantly above the counterfactual as digitalisation spreads to most consumers and businesses, resulting in a narrow digital divide. Digital technologies are widely used, but worries about over reliance on technology constrain the widespread use of the most advanced technologies.

- **Scenario 3: Scotland as an ICT world leader**

Penetration and usage grow quickly as Scotland becomes a world leader in digitalisation. Consumer usage of higher definition audio-visual drives large increases in usage and digital technologies and widely used in the home, for business, across cities and for public service provision.

The scenarios are expressed as increments to a counterfactual scenario which represents what may happen to digital markets if there are only changes due to demographic change and current trends in the market. Each scenario then builds on the counterfactual so that the demographic change and current trends occur as part of each scenarios' increase in penetration and usage.

Figure 19: Scenario analysis



Source: Deloitte analysis

Information from the DCMS/SFT scenarios, from the Scottish Government and Ofcom and from market analysts and participants such as Cisco were used to inform a number of assumptions that attach penetration and usage figures to the scenarios. A review of international benchmarks was undertaken for each scenario profile in order to inform the current view on each of the profiles. These scenarios assume that the network requirements, such as superfast broadband, as well as service availability and development for the demand scenarios to occur are met.

[24] DCMS (2014), Digital Communication Infrastructure Strategy Consultation document
[25] For more detail on each scenario pleases see Appendix A.

2.3 Scenario definition

A summary of the incremental changes in each Scenario is depicted below.

Figure 20: The digital enhancement scenarios: incremental changes by 2030

Source: Deloitte analysis

More details on the counterfactual and the scenarios are presented below and in the appendices.

Counterfactual scenario

The counterfactual incorporates demographic change and current trends, therefore representing the scenario where no action is taken to improve the digitalisation of Scotland. The proportion of people with internet is expected to reach 90% by the end of the period through demographic change resulting in a narrowing of the age digital divide.[26] The digital divide in terms of geography and income remains with rural areas using the internet less and poorer households are still less likely to have an internet connection. A divide also exists in business usage with larger businesses making more use of digital technologies.

Figure 21: Usage in the counterfactual

Usage type	Description
Audio-visual and social media 	Demand for linear TV remains strong restricting the amount of time people spend watching programmes on non-TV devices. The demand for higher definition TV is also not high with the majority of people watching HD TV rather than Ultra HD TV.
Consumer 	The use of the internet to research and access goods and services has increased due to demographic reasons. The use of the internet for shopping, banking and news is restricted by it only being highly used by the younger generations.
Business 	The majority of the improvements in digitalisation are due to larger businesses making greater use of NGA broadband and digital technologies such as cloud computing. Digitalisation amongst very small firms such as SOHOs remains comparatively limited which has held back the number of firms engaging in e-commerce.
Public sector 	Digitalisation of the public administration has improved slightly but is still limited and fragmented. Many public bodies have started using their own cloud systems and just over half of the messages in the NHS are digitalised. The online portal has been completed allowing for a few services to be offered online and local councils offer services such as planning permission and council tax online. There have been modest improvements in the digitalisation of services and use of devices in the NHS and education.
Internet of things 	Only modest improvements have been made in integrating internet connected devices into everyday life and business. Whilst there are 25 million devices, many of these are used by big businesses for the monitoring of equipment. Consumer use is generally limited to smart meters and in some cars.

Source: Deloitte analysis

Incremental improvement

Scenario 1 represents an incremental improvement over the counterfactual. An additional 3% of the population use internet, up to 93%. The digital divide is still present although there is a slight narrowing with people in rural areas making more use of the internet. There is also a slight narrowing in the business use divide as the use of digital technologies by smaller firms is higher than under the counterfactual.

[26] Scottish Household survey 2013

Figure 22: An incremental improvement in usage

Usage type	Description
Audio-visual and social media 	Whilst demand for linear TV has remained fairly resilient, the amount of time people spend watching programmes on non-TV devices has increased slightly. There has also been a shift to Ultra HD with the majority now viewing this on their devices.
Consumer 	The use of the internet to research and access goods and services has become slightly more common in society although the majority of the elderly are still not using the internet for shopping, banking and news access.
Business 	As in the counterfactual the majority of the improvements in digitalisation are due to larger businesses making greater use of NGA broadband and digital technologies such as cloud computing. There have been small improvements in the digitalisation of smaller firms with the majority of SMEs using NGA broadband and cloud computing. The increased digitalisation has enabled a small increase in the number of firms using e-commerce.
Public sector 	Progress has been made in the digitalisation of public administration with most departments, public bodies and councils using cloud computing. Doctors can use an online health portal containing the majority of health records. More services are available through the online portal and devices. Devices are becoming commonplace in healthcare provision but digital technologies only supplement learning rather than being embedded in education.
Internet of things 	There are an extra 5 million connected devices in Scotland. Whilst the majority of the devices are still being used by big businesses, there are now a minority of consumers who are able to experience the benefits of connected devices talking to each other.

Source: Deloitte analysis

World Class digitalisation

In Scenario 2 Scotland is now a world class country in terms of digitalisation, thus representing a significant improvement over the counterfactual and Scenario 1. An extra 4% of the population are now using the internet. Whilst there still is a digital divide, it has substantially narrowed compared to the previous scenarios. This results in usage in more rural areas closing the gap with urban areas and smaller businesses also close the gap in using digital technologies as more bespoke products and services are available which better meet their needs.

Figure 23: Usage in a scenario of world class digitalisation

Usage type	Description
Audio-visual and social media 	Demand for audio-visual content delivered over the internet has increased with more people using video-on-demand and catch-up services as well as whilst on the move. The demand for higher definition content has increased with the majority now viewing Ultra HD content and a some early adopters viewing 8K TV.
Consumer 	The use of the internet for shopping, banking and accessing news has increased significantly so that now over 85% are making some use of these services via the internet.
Business 	Increased digitalisation is no longer restricted to larger businesses with the majority of SOHOs and SMEs using NGA broadband with nearly all firms using cloud computing, which helps to facilitate remote working for employees. The improved levels of digitalisation in smaller firms has enabled an increase in e-commerce with two-thirds of firms now making some sales online.
Public sector 	Public sector administration in central government, councils and the NHS is nearly fully digitalised with a relatively high level of interoperability. The government offers many online services which are used by the majority of the population. The use of devices in healthcare is common and quite advanced, although some of the most cutting edge devices are not yet used, and digital technology has been integrated into education although there is an implementation gap.
Internet of things 	Demand for IoT devices has taken off, reaching 90 million devices and being widely used by many consumers and nearly all businesses. This allows businesses to do preventative maintenance instead of repairs and the devices are embedded in everyday life for consumers.

Source: Deloitte analysis

Scotland as a digital world leader

In Scenario 3 Scotland is now a world class country in terms of digitalisation, thus representing a significant improvement over the counterfactual and Scenario 1. There is seamless transition between fixed and mobile networks and consumers expect to be able to access them wherever and whenever. Nearly everyone is using the internet with 99% of people using the internet. The digital divide effectively no longer exists with all groups of society using the internet and digital technologies a similar amount.

Figure 24: World leading usage

Usage type	Description
Audio-visual and social media 	Demand for audio-visual content delivered over the internet has increased so that they are now spending over twice as much time viewing internet delivered content compared to in the counterfactual. Demand for higher definition content is high with the large majority viewing Ultra HD content and the transition to 8K content is underway.
Consumer 	Nearly everyone is using the internet for shopping and accessing financial services through online banking. The internet is the most regular place that people go to find out about news and find information.
Business 	Virtually all firms have access to NGA broadband with a high level of digitalisation making to easier for employees to work remotely. The embedding of digital technologies in businesses has enabled three-quarters of firms to sell via their websites. The majority of firms are also using advanced digital tools such as big data analytics.
Public sector 	Public sector administration in central government, councils and the NHS is fully digitalised with a high level of interoperability. The government offers many online services, which are used by the 90%of the population, and moving into smart government so people can interact with the government anywhere anytime. Advanced devices and live monitoring is used in healthcare to care for people and the use of digital technologies in education is embedded in the delivery of education.
Internet of things 	Demand for IoT devices is very high, reaching 130 million devices. This has enabled digital technologies to be present in nearly all walks of life and smart city applications are widespread improving the quality of life for people.

Source: Deloitte analysis

3 The economic impacts of enhanced digitalisation

Digitalisation has already changed many aspects of the lives of individuals in Scotland, from reducing isolation in remote areas to creating new ways to communicate and socialise, new business models and industries, and more efficient ways for firms and workers to operate. Innovations such as search engines, online marketplaces and social media, as well as the convergence of these platforms with nearly all existing activities, have permeated the Scottish society and impacted productivity, economic growth and business creation. These platforms have also started to change the way in which public services, healthcare and education are provided and shared.

This section discusses the potential economic impacts that could be associated with the enhanced digitalisation scenarios prepared by SFT. It discusses how changes in penetration and usage, service availability and business connectivity can impact economic activity, business creation and innovation, jobs, as well as a number of other economic indicators.

The analysis, which is scenario-based and forward looking, is based on a set of demographic and economic forecasts prepared by institutions such as the Office for National Statistics (ONS) and the Scottish Government. It is also based on a review of the impacts of digitalisation on a set of economic factors as estimated by numerous international and Scottish specific studies. These studies, typically based on statistical or econometric analysis, review the historic impacts of digitalisation. These impacts are then applied to the scenarios to estimate the economic impact of each digitalisation scenario. One of the key features of digitalisation is the transformational nature of the impacts generated on consumer behaviours, business propositions and industries; while the extent of these transformations cannot be fully grasped in advance (for example, the iPhone was launched less than eight years ago and its effects were unpredictable), the potential disruptive impacts of internet-based services and the transformational opportunities associated with these trends are also considered.

3.1 How digitalisation impacts the economy

Enhanced digitalisation offers unprecedented opportunities for economic growth. By providing access to information, connecting people to businesses anywhere, and opening up new markets, the internet is transforming the very nature of economies and supporting economic development. By empowering workers with information, internet access can kick-start economic growth for individuals in all geographic areas and improve productivity, create jobs and reduce poverty. A number of mobile and internet-based services have already emerged that have transformed the way in which nearly all professions, from fishermen to small businesses and large enterprises, and ultimately consumers, benefit from increased efficiencies. Studies undertaken in the UK estimate that the digital economy accounted for 8.3% of the UK's GDP in 2010 and may reach 12.4% by 2016.[27]

The scenarios prepared by SFT define increasing levels of digitalisation from today's levels up to complete and embedded digitalisation across the whole of Scotland. Increased levels of internet penetration, availability of mobile devices and business access and usage are some of the key drivers of the economic impacts associated with the increasing digitalisation:

- By further increasing access to information, widespread digitalisation can increase productivity and enable markets to function more efficiently.
- The ability to send more and more complex information and data via mobile devices and the internet reduces travel time and costs and increases time savings and organisational efficiency. These can be material for all businesses as high impact technologies spread.
- Extending internet access and internet-based services to nearly all activities and locations can further increase market efficiency by removing barriers to entry, reducing transaction costs and increasing transparency. A higher web economy also facilitates sales and exports by acting as a worldwide advertising platform.

[27] BCG, The internet economy in the G-20

- The improved information flows due to ubiquitous internet access can also foster innovation and new businesses through the spreading of ideas and making it possible for businesses and consumers to make use of new research and technologies.
- Ultimately, increased productivity of capital and labour leads to higher economic growth, jobs, earnings.

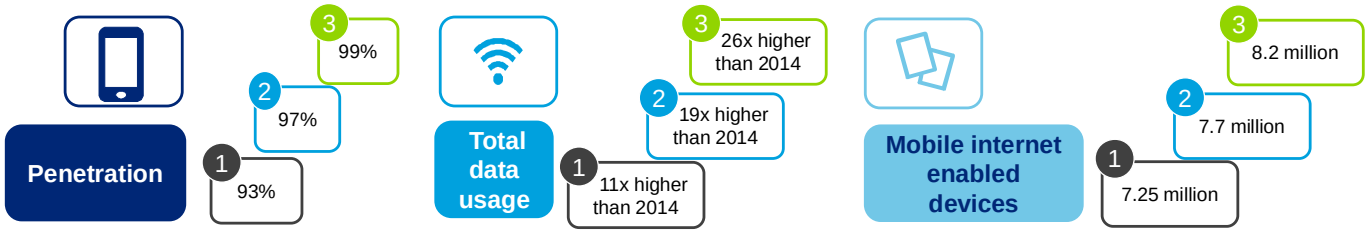
The variation of these drivers across scenarios is discussed below, along with a key set of economic impacts that can be generated as a result.

Increased penetration and usage levels

Increasing levels of penetration enable greater access to information and to seamless digital experience, and while today's level of digital penetration in Scotland is high, ubiquitous penetration has important impacts on those consumers and businesses that remain excluded from internet consumption, potentially delivering significant social benefits.

Economic growth from digitalisation is also driven by the significant increase in digital usage discussed in Section 2, i.e. by how people and businesses use the internet. Increasing levels of digitalisation will increase the usage of the internet both at the home and on the move. Whilst a large proportion of the data consumption is likely to consist of audio-visual usage, which may have an impact on the media sector but is mostly associated with leisure time, usage of the internet and digital technologies by businesses and the public sector also increase as Scotland becomes more digitalised.

Figure 25: Internet penetration and usage levels in the scenarios



Source: Deloitte analysis

The impacts of increased internet access on the economy have been widely recognised in a large number of studies in recent years. For example, a study for the Organisation for Economic Co-operation and Development (OECD) focusing on broadband penetration in 25 OECD countries between 1996 and 2007 found that a 10% increase in broadband penetration raises GDP per capita growth by 0.9 to 1.5 percentage points.[28] A World Bank study looking at 66 high income countries between 1980 and 2002 found a similar result with an equivalent increase in broadband penetration adding 1.2 percentage points onto GDP growth.[29] Deloitte has also undertaken quantitative analysis focusing on how internet access affects the economy. Deloitte, in a report for BT, prepared an econometric analysis of how fixed and mobile penetration impacted GDP in EU27 and OECD countries over a 10 year period between 2002 and 2012. This found robust results that showed a 10% increase in fixed and mobile penetration increased a countries GDP growth rate by 0.88% and 0.63% respectively. [30]

The effects of digital usage on the economy have been less widely studied due to a lack of aggregated data on internet usage. As of today, the only significant study on the relationship between internet usage and economic growth was undertaken by Deloitte, GSMA and Cisco in 2012, measuring the relationship between usage of mobile internet data and economic growth in 14 countries, including the UK, between 2005 and 2010 and found that doubling mobile data usage per connection could increase GDP per capita by up to 1.5%, with the impact in the UK being approximately 1.1%.[31] In a scenario of world leading digitalisation mobile data usage per connection may be 110 times higher than in 2014 and fixed data usage is 20 times higher.

Quantifying the economic impacts of usage increases is also complex as different services provide different benefits: services that are connected to higher productivity increases, such as banking and M2M communications, typically consume little data,

[28] Czernich, N., Falck, O., Kretschmer T., & Woessman, L. (2009, December). Broadband infrastructure and economic growth (CESifo Working Paper No. 2861)
[29] Qiang, C. Z., & Rossotto, C. M. (2009). Economic Impacts of Broadband. In Information and Communications for Development 2009: Extending Reach and Increasing Impact, 35–50.Washington, DC: World Bank
[30] Details in Appendix B
[31] Deloitte, GSMA, Cisco 2012, What is the impact of mobile telephony on economic growth?

while services such as online entertainment may deliver lower productivity levels and exhibit high usage volumes. Critically, usage also depends on compression technologies. Going forward, it is expected that the patterns between data usage and the economy will change as new applications, such as IoT devices, are introduced which do not use much data but may have a large economic impact. As such, the macroeconomic impacts of enhanced digitalisation are estimated using the robust relationships between penetration and economic growth, and supplemented by a series of further measurements relating business performance to the uptake of new digital technologies.

Increased digital usage by businesses

A key differentiator across the three digitalisation scenarios is how businesses connect to NGN and the technologies increased digitalisation allows them to employ. The economic impacts of three main technologies are explored: cloud computing, big data analytics and the IoT.

Figure 26: Business solution penetration across scenarios[32]

Source: Deloitte analysis

Cloud computing is the use of a shared pool of IT resources, which can include servers, storage and applications. IT infrastructure can represent a significant start-up cost for businesses and reducing these initial start-up costs can make it easier for new firms to set up as less upfront expenditure and investment is necessary. The Cloud allows IT infrastructure costs to be transferred from CAPEX to OPEX and deliver notable savings and process efficiencies. Many cloud services contain software such as management software that can be used to improve business development through the use of supply chain and customer management software. Finally, using the cloud can encourage innovation and new business models such as making e-commerce easier through using the cloud as a platform and making it easier for employees to get a whole view of the firm by accessing a larger amount of data and information.

Big data. As the world becomes increasingly digitalised, there is ever more data being collected by mobile devices as well as software and internet logs. Analysing this data can improve knowledge about customer preferences, supply chain management, performance, quality and risk management and fraud detection. This has potential applications across much of the private and public sector to improve the quality of services and reduce costs as well as encouraging innovation and business creation.

The IoT consists of objects and machines that are connected to the internet. This allows them to send report and receive information as well as being controlled remotely. This can generate data that can be analysed using big data analytics. Applications of IoT have the potential to benefit businesses, consumers and the public sector. Using IoT devices has the potential to reduce costs in many sectors, increase sales and deliver benefits to consumers in reduced expenditure on energy. Other benefits include improved traffic management and environmental benefits through the implementation of smart cities.

To estimate the impacts of cloud computing and big data analytics, studies focusing on the economic impacts of using these technologies were applied to each level of digitalisation. The estimation of the IoT impacts applied a number of cost saving and revenue enhancing benefits from using IoT devices in different sectors to the economy of Scotland.[33]

As businesses and the public sector increasingly make more use of these technologies, this will open up new business opportunities and innovation through improved access and understanding of markets, support the creation of new businesses by reducing barriers to entry as well as improving productivity and generating jobs. As digitalisation in the economy increases across the scenarios, consumers will increasingly expect to be able to interact with businesses and the public sector to gather information and access goods and services. Higher levels of digitalisation in businesses and the public sector will help

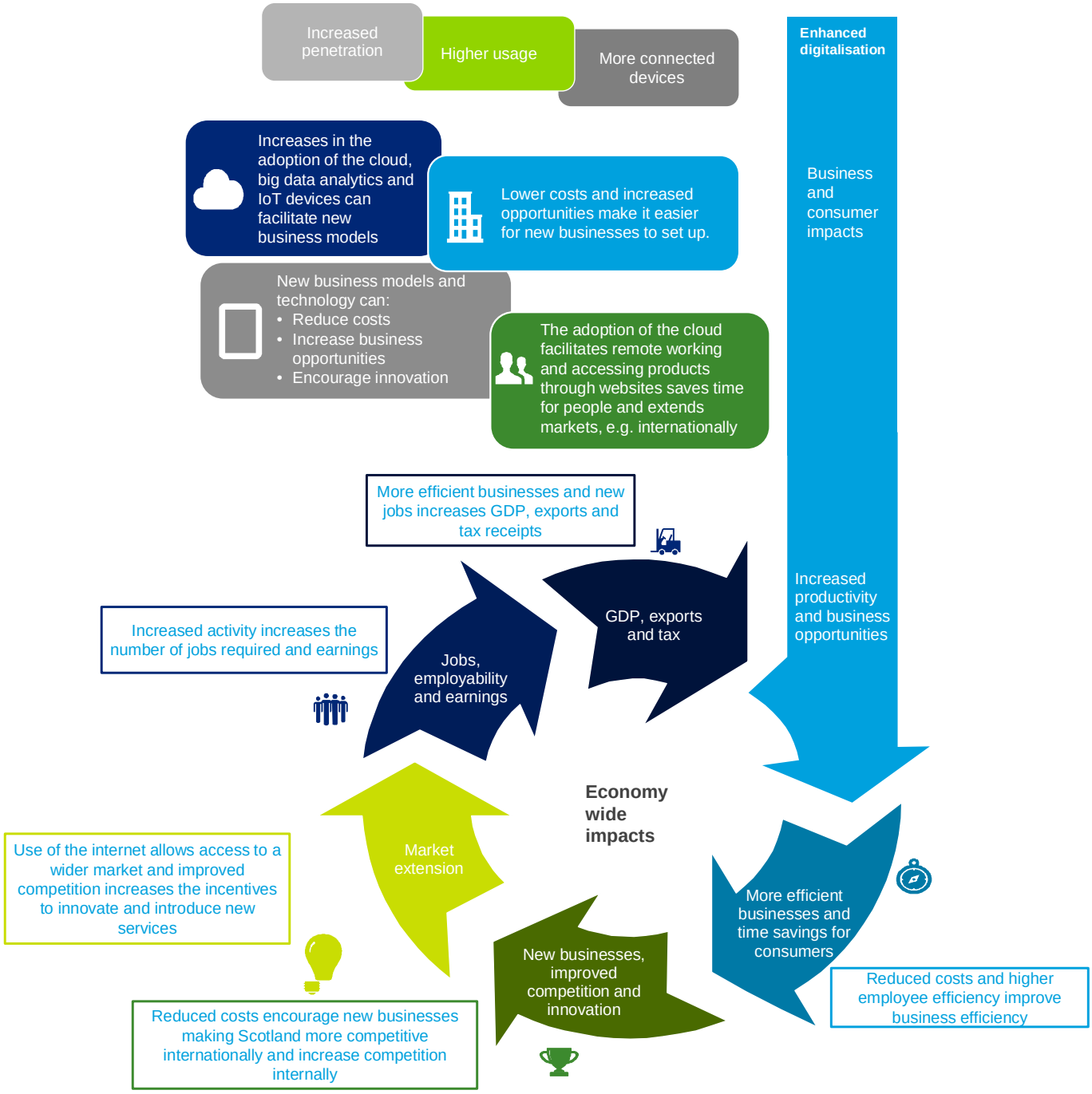
[32] The numbers for cloud computing and big data analytics are the proportion of total businesses making use of these technologies.
[33] See Appendix B for more details

consumers achieve this aim. This will allow consumers to save time in travelling and information gathering and will increase access goods and services that were otherwise unavailable to them.

The economic framework

Based on the drivers described above, the macroeconomic estimations linked to penetration increases are combined with a set of microeconomic indicators linked to new technology access by businesses, to provide a view of the economic benefits generated by increased digitalisation, as illustrated in Figure 27. In addition to the direct impacts on productivity, GDP, business creation and jobs, indirect impacts include increased exports through more efficient firms, and hence more competitive products, with increased access to markets through e-commerce and increased tax revenue generated in Scotland through the increased economic activity. Enhanced digitalisation will increasingly allow for people to experience time savings from reduced commuting, through increased opportunities for remote working, and fewer trips to the shops as they make more use of online shopping.

Figure 27: Economic impacts of enhanced digital access



Source: Deloitte analysis

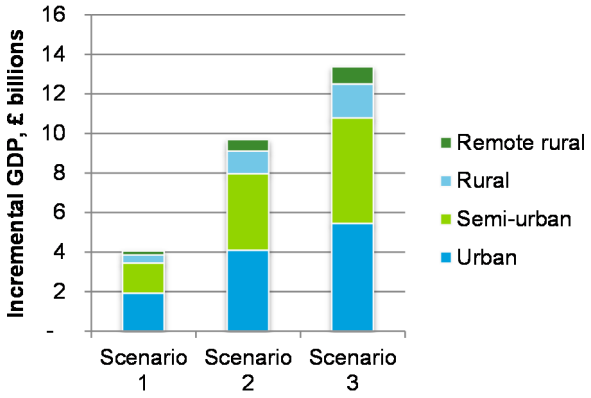
The economic impacts of the scenarios of enhanced digitalisation are presented as incremental additions to the counterfactual, i.e. a scenario that represents what would happen to the Scotland should existing trends continue. This assumes GDP growth of 2% per year and population growth forecasted by the Scottish Government. Unless stated otherwise, these impacts are the total incremental impact by 2030, rather than the impact in 2030, and are reported in 2014values.

3.2 Impact on GDP growth and productivity

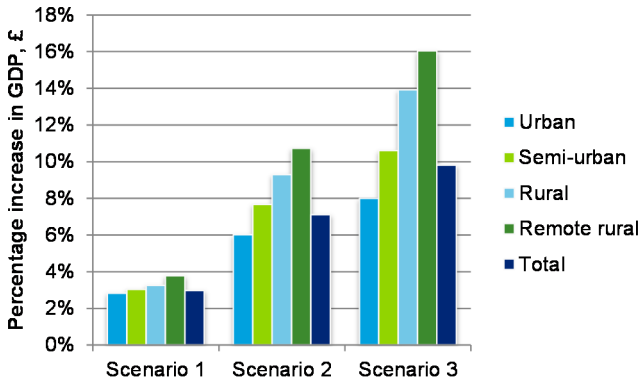
To capture the overall GDP impacts of digitalisation, the relationship between increases in digital penetration and GDP as measured by a recent Deloitte/BT study and the impacts of new technologies discussed above are applied to the scenarios of enhanced digitalisation: increases in penetration and uses of new technologies are linked to corresponding increases in economic activity indicated in the reviewed economic papers. This suggests that, if Scotland becomes a digitalisation world leader, GDP could increase by over £13bn by 2030 compared to the counterfactual, representing a 9.8% increase in GDP compared to that in 2014 and over £100bn on a cumulative basis. However, if Scotland only experiences an incremental improvement in digitalisation then this benefit could fall to only £4bn. On an annual basis, the penetration increase profile may lead to an average 0.5% GDP growth factor due to digitalisation in Scenario 3, with the same factor at 0.36% and 0.16% in Scenario 2 and Scenario 1 respectively. This is compared to an annual growth rate of approximately 3% between 2002 and 2007 (prior to the recession) and represents a 25% and 18% increase in the annual growth rate compared to the counterfactual.[34]

Increasing levels of digitalisation in rural areas compared to the current profile are likely to result in an increasing proportion of the incremental economic growth being generated in rural areas; in the case of incremental improvement only 15% of the extra activity is in rural areas, compared to 20% when Scotland is a world leader. These results suggest that, in a situation where rural Scotland, for example, reached world leading digitalisation, but other areas do not, then this could still result in an increase in rural GDP of £1.7bn. Similarly, if urban areas reached world class digitalisation but other areas only experience a small improvement on top of the counterfactual, then this could result in an increase in GDP of £4bn in urban areas and impacts similar to those in scenario 1 for other areas.

Figure 28: Incremental GDP by 2030, £ billions[35]



Percentage increases in GDP compared to 2014

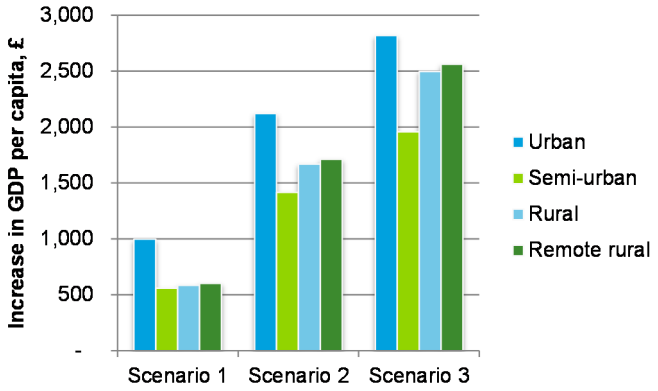


Source: Deloitte analysis

Whilst the proportion of the extra GDP that is rural is relatively small, this corresponds to GDP per capita increases of approximately £2,500 in a scenario of world leading digitalisation and £1,700 in a scenario of world class digitalisation. For remote rural areas this represents a 15% increase compared to 2014 GDP per capita levels. At the household level, the average increase in GDP is over £5,000 per household. It is worth noting that one of the reasons why the increase in semi-urban is lower is that these areas currently have comparably high levels of digitalisation, which reduces the increase in digitalisation, and the economic data does not take commuting into account so there may be some spill over from urban to semi-urban areas.

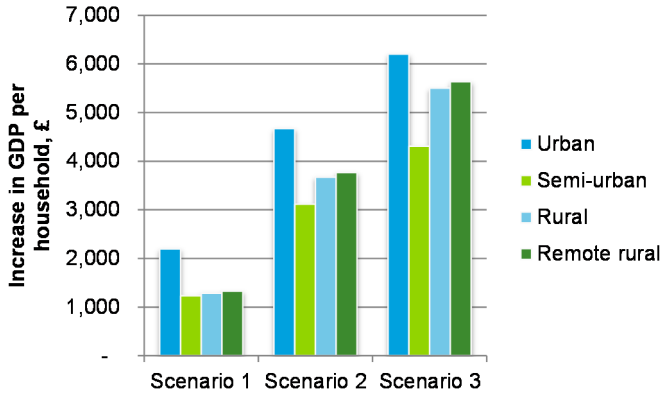
[34] Scottish Government statistics
[35] Where possible the impacts on the economy have also been broken down by SOHO, SME and large firms. See Section 3.3 for more details.

Figure 29: Incremental increase in GDP per capita by 2030



Source: Deloitte analysis

Figure 30: Incremental increase in GDP per household by 2030

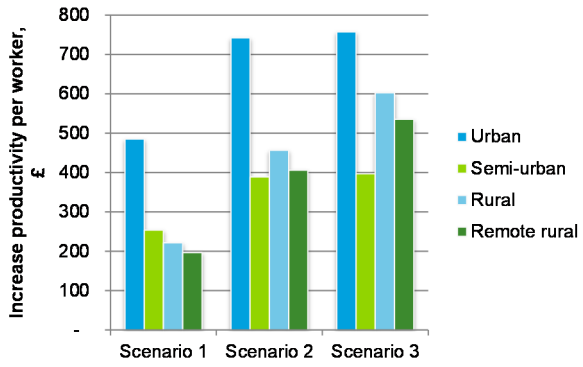


Source: Deloitte analysis

A key driver for this economic growth in the long run is productivity. In 2012, Scotland was ranked in the bottom half relative to OECD countries in terms of productivity per hour worked and up to 2011 had been closing the gap between itself and the top 25% of OECD countries.[36] The impact of digitalisation on productivity is calculated by applying studies on the impact of broadband penetration and cloud adoption rates, which find that a 10% increase in broadband and cloud penetration results in a 1% and 0.16% increase in productivity respectively, to the scenarios.[37] The level of productivity per worker is expected to increase the most in urban areas: however, as the digital divide narrows in more digitalised scenarios, the majority of the incremental productivity improvements occur in rural areas. Productivity improvements in semi-urban areas are lower than rural areas in the scenarios of higher levels of digitalisation as they affected by higher current levels of usage and commuting to other areas not being factored into the economic data, which has the potential for spill over from urban to semi-urban areas. Additionally, there are only small increases for urban and semi-urban between the scenarios of world class digitalisation and world leading digitalisation because the majority of the improvement in internet penetration and cloud usage has already occurred in the scenario of world class digitalisation.

[36] Organisation for Economic Co-operation and Development, Office for National Statistics
[37] See Appendix B for more details. The impact for the different firm types is estimated by using the number of extra businesses using the technology weighted by their relative turnover under each scenario.

Figure 31: Incremental increase in labour productivity by 2030



Source: Deloitte analysis

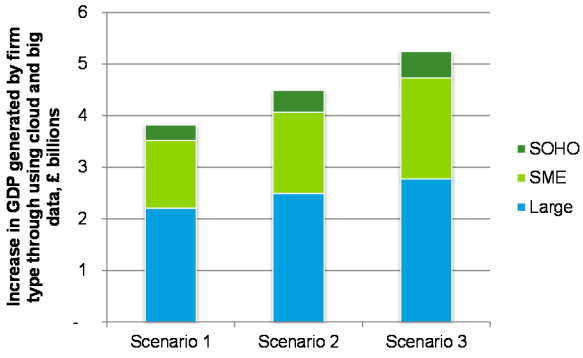
3.3 Business impacts

One of the drivers of the economic impacts presented above is the adoption of new technologies by businesses. For example:

- Cloud: A CEBR (Centre for Economics and Business Research) study on cloud computing in the UK finds that increasing the usage of cloud computing from 32% of businesses to 56% of businesses from 2010 to 2015 resulted in a cumulative impact on GDP of 1.26% of UK GDP over that period.[38]
- Big Data: Similarly, the CEBR finds that increasing big data usage from 34% of firms to 54% of firms resulted in additional economic impact of over £15bn.[39]

On this basis, and considering the number of firms in each scenario that adopt these technologies, it is estimated that the economic impacts from world leading uses of cloud technology and big data could result in economic benefits of over £5bn. As digitalisation in Scotland increases across the scenarios, a greater proportion of this benefit is generated by SOHOs and SMEs, up from 42% of the benefit when there is incremental improvement, to 44% when digitalisation is world leading and 47% when digitalisation is world leading. For example, in the case of world class digitalisation, 70% of the potential benefits from big data analytics are driven by SMEs and SOHOs.

Figure 32: Increase in GDP generated by firms using cloud technology and big data analytics[40]



Source: Deloitte analysis

A key component of the economic benefit of increasing digitalisation shown in Figure 32 relates to cost savings and efficiencies that will accrue to Scottish businesses. Reports by the CEBR find that a quarter of the total benefits from cloud technologies and almost 70% of the benefits from big data relate to cost savings.[41] On this basis, in 2030 in a scenario of world class digitalisation, an extra 14,500 extra firms (primarily SOHOs) could save approximately £26,000 from using cloud computing (this excludes expenditure on cloud services).

[38] CEBR, "The Cloud Dividend"
[39] CEBR, "Data equity: Unlocking the value of big data"
[40] Note that this takes expenditure on cloud services into account
[41] CEBR, "The Cloud Dividend" and "Data equity: Unlocking the value of big data"

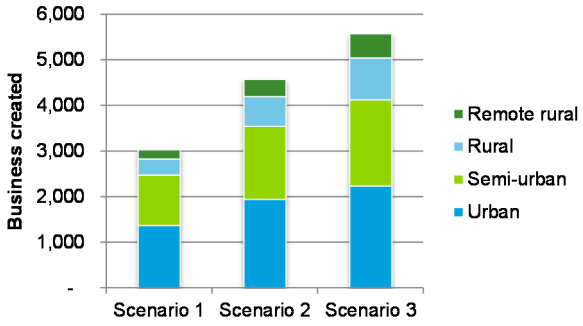
Business creation

Business creation occurs through reduced barriers to entry, for example through cloud computing reducing fixed costs, and digital technologies, such as big data analytics, opening up new business opportunities. This assumes access to sufficient infrastructure and services.

A recent report, which estimates the economic impact of superfast broadband in different geographic areas in the UK, finds that superfast broadband coverage encourages business creation through reducing barriers to entry. [42] The report finds that, for every 100 firms reached with superfast broadband, there are approximately six business start-ups created. This number was slightly higher in more urban areas.

On the basis of the business creation benefits of cloud computing and big data estimated in the CEBR papers and the average value added of SOHOs and SMEs, world leading digitalisation may create nearly 6,000 new SOHOs and SMEs over the period in Scotland, with 10% of these in remote rural areas, which is slightly less than the proportion of businesses that are in remote rural areas. This is compared to 4,500 new firms in a scenario of world class digitalisation with only 8% of these being in remote rural areas.

Figure 33: SOHOs and SMEs created by enhanced digitalisation



Source: Deloitte analysis

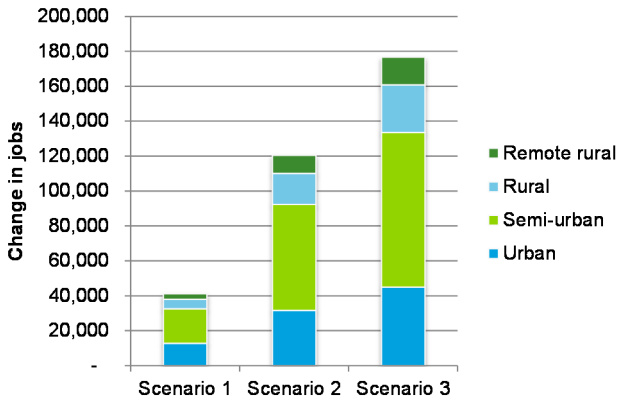
The increase in digitalisation may have an impact on telecommunications and ICT companies in Scotland. In 2011, the telecommunications, information and computer services accounted for approximately 3% of Scottish value added.[43] For example increasing levels of digitalisation may also encourage data centres to set up in Scotland, which will help improve the quality of cloud services. These can result in a significant amount of investment, for example Google has invested €225m in data centres in Dublin since 2012.[44]

Jobs, Labour force participation and Earnings

Increased economic activity through business creation and increased business opportunities for existing firms increases the demand for workers, creating new jobs. A recent study that considered the impacts of connecting businesses with superfast broadband in Cornwall found that connecting 10,000 firms is likely to generate 2,300 full time jobs and safeguard 3,000 jobs.[45] On this basis, if Scotland becomes a digital world leader, increased digitalisation may generate an extra 175,000 jobs, representing an increase in those employed by 6% in 2030. This is an increase of 55,000 jobs compared to when there is world class digitalisation. The increase in jobs may have a significant benefit for those between 18 and 24, for whom the unemployment rate at the end of 2014 is approximately 17.7%, as an increase in digital related jobs may be suited to this age group due to the higher internet penetration and digital abilities of young people. Based on today's geographic job dissemination, the majority of additional jobs would be created in semi-urban areas.

[42] Regeneris, Superfast Broadband: Boosting Business and the UK Economy
[43] Input-Output tables, Scottish Government
[44] http://www.independent.ie/business/irish/google-to-build-new-150m-data-centre-in-dublin-30012987.html
[45] University of Plymouth, Superfast Cornwall Evaluation update report April 2014

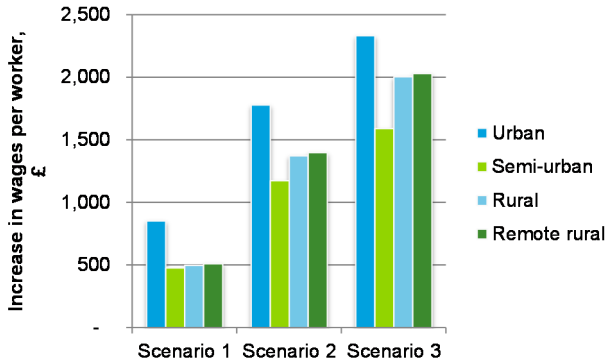
Figure 34: Additional jobs from digitalisation



Source: Deloitte analysis

The increased demand for labour, which is more productive, also increases earnings. By applying the effect of an increase of final demand on incomes, this increase is estimated to be up to £2,000 per worker in a scenario of world leading digitalisation, equivalent to almost an 8% increase in come, and £1,400 per worker when there is world class digitalisation.[46] This represents a cumulative increase of £15,000 per worker when digitalisation is 'world leading' and £11,000 per worker when it is 'world class'. Whilst the increase per person by the end of the period is estimated to be higher for people in urban areas across all three levels of digitalisation, the biggest relative gain is estimated for people living in rural areas.

Figure 35: Increase in earnings



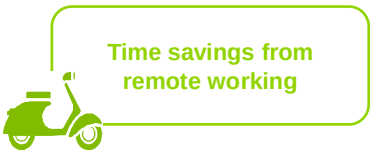
Source: Deloitte analysis

Increased digitalisation impacts labour participation through two channels:

- Higher earnings and more jobs created, reducing unemployment in the short term, increase the likelihood that more unemployed enter the labour market looking for work, as the cost of not working increases when there is a higher probability of earning a higher salary. This robust relationship in labour economics has been further confirmed recently by an OECD report that finds that, amongst other factors, higher wages and lower unemployment increases the likelihood of women entering the labour market.[47] Today, women's labour participation rate in Scotland is at 75%, suggesting room for increased female participation.[48]
- Increased work flexibility generated as a result of effective and widespread teleworking can also improve labour participation.[49] Teleworking is one such way that people can work more flexibly as they can use digital technologies to access work from home or wherever they need to. For example, the number of people teleworking at least half the time in the United States has grown by 80% since 2005 and, in 2012, 2.6% of non-self-employed employees used teleworking at

[46] The income effect is taken from the Scottish Government's Input-Output tables. For a unit increase in final demand incomes increase by 0.44.
[47] Jaumotte, 2003, Female labour participation: Past trends and main determinants in OECD countries
[48] ONS, Labour force survey
[49] European Foundation for the Improvement of Living and Working Conditions, Reconciliation of work, private and family life in the European Union

least half the time.[50] It is estimated that in 2014 there may have been approximately 25 million people who use teleworking at least once per month.



In addition to generating employment, teleworking can create significant time savings for those with an existing job. These time savings allow employees to reallocate that time to other activities, part of which can generate additional economic impact. Data on the average commute time, the value of one hour of commuting time (estimate by the Department of Transport) and the relative commute times between urban and rural areas can be used to estimate the economic value of remote working.[51] If 20% of employees in Scotland work remotely two days a week, then this could generate a value of £325m every year, with a third of this being in rural areas (despite only 20% of the population living in rural areas).

In a scenario of enhanced digitalisation where nearly all firms use cloud computing, there is potential for a large amount of teleworking. This may allow them to save commuting time at least some of the time and for some to work from home the majority of the time. This may make it easier for people in rural areas to work in towns and cities as they would not need to commute as often as well as reducing lost working days due to travel disruptions in winter.

Innovation

Innovation can result in new or better products and services as well as contributing to higher productivity in the economy and is as such a key indicator for long term growth in GDP and earnings. Digital-led innovation has been critical across economies in recent years and the internet and connected devices, such as smartphones and tablets, are platforms that enable businesses to create new applications that operate using access to fixed and mobile networks and use smartphones as an interface. Apps for smartphones are one example of innovation because of the internet and smartphone technology. This industry has expanded rapidly over a few years resulting in significant changes to the economy and society, from sectors such as transport to banking, retail, audio-video, and travels.

Figure 36: Internet and smart devices as a platform for innovation[52]

The use of the internet and smartphones as a platform makes it possible for new applications to grow very quickly and have a significant impact in the market they operate in.

One such example is Uber, which was founded in 2009 and is now present in 55 countries and hundreds of cities. Uber connects drivers and people who need lifts using an app. The app includes features such as showing the route and expected fare. Uber is also experimenting with UberPool which will allow people making similar journeys to find each other and share a lift.

It is also possible for other firms to use Uber's application programming interface (API) to improve the functionality of their own apps as well as save time in the development process. Starbucks and Trip Advisor are amongst those who have used Uber's API.

Source: Uber.com

By connecting people, the internet has enabled websites to develop that allow people from across the world to work together and share ideas. This can result in ecosystems being developed that enable businesses to work together to innovate at a faster rate than otherwise possible. One such example of an ecosystem is the so called Application Programming Interface (API) economy, which is the exchange of business functions and capabilities of services that use APIs. APIs provide much of the basic functionality in systems, websites and apps such as log in functions. There are many examples of companies, such as Amazon and Google, which have developed rich ecosystems that include many participants who can improve the ecosystem through either creating content, APIs and apps and help to spread knowledge of the ecosystem and new products.

[50] http://globalworkplaceanalytics.com/telecommuting-statistics
[51] Department for Transport WebTag databook Nov 2014, Labour force survey (2012) and ONS data on commuting time.
[52] Application programming interface (API) is a set of routines, protocols and tools for building software applications.

Figure 37: Connecting people and ideas: The case of GitHub

GitHub is a large repository of code for programming that allows people to develop new software as well as providing support with inbuilt tools in the website. This encourages innovation of new tools and applications through supporting innovative ideas. Businesses such as PayPal and SAP have also used it.

GitHub includes code and tools that look at open journalism, government apps, data visualisation, productivity and video tools, music and gaming. Examples of projects and organisations that have information on GitHub include:

- White House online petitions
- Whitehall App/Inside government
- New York Times and Buzzfeed

Source: GitHub.com

IoT devices are another innovation that uses the internet, and smartphones for many consumer applications. This is still in its infancy and presents an opportunity for innovations, especially when the use of big data analytics is increasing so that lessons can be learnt from the data that the devices generate encouraging further innovation. As levels of take up of IoT devices increase across the different levels of digitalisation, it would be expected that IoT related innovation would also increase.

Figure 38: IoT devices in the transport sector

One potential innovation due to IoT devices relates to the transport sector. In a case of advanced digitalisation all cars contain IoT devices. This would enable intelligent traffic management systems which use IoT devices to control the flow of traffic through controlling the speed of the car and suggesting different routes to avoid traffic jams. This would help to reduce congestion and delays. These devices could also be used to monitor mechanical parts of cars which can be used to replace a part before it fails.

The government estimates that road congestion costs the UK economy over £7bn a year. By using IoT devices to reduce congestion this could create a significant amount of economic value as well as environmental benefits and generating savings through reducing the need to build more roads.

Source: Ofcom

E-commerce

An increasingly common change to business models resulting from digitalisation is the incorporation of e-commerce in numerous business activities. E-commerce can encompass both the use of digital technologies in the business and also selling to other businesses and consumers by using the internet.[53] As the economy becomes increasingly digitised, it is expected that firms will make more use of the internet for sales.

Selling to customers online also enables a more effective method of communicating with customers. Online advertising can be more effective than traditional advertising whilst still having positive impacts on in-store sales and online sales. One of the main reasons for the increased effectiveness is that it is easier to tailor the advert to the person through collecting data on their search preferences.

A recent academic study on the relationship between online and offline sales in the US finds that in the long term, a 10% increase in spend on online display and search advertising increases sales by 1.4% and 4.9% respectively compared to an increase of 0.25% for a 10% increase in traditional advertising spend.[54] The paper also found that online advertising has a positive effect on in-store sales. This results in large returns on investment for online investment in both the store and online. As well as improved sales from advertising online, the increased effectiveness of online advertising can reduce advertising costs for businesses and allow it to invest more on research and development.

In addition to online advertising, firms can also make use of social media to advertise and promote their products. A study by Deloitte focused on the impact on sales from tweets compared to non-Twitter advertising.[55] The study used econometric

[53] The use of digital technologies in business operations has been widely discussed in previous sections so this section will primarily focus on selling over the internet.
[54] Dinner, I., van Heerde, H., and Neslin, S., 2011, Driving Online and Offline Sales: The Cross-Channel Effects of Digital versus Traditional Advertising
[55] Deloitte, 2013, Tweets for Sales: Gaming

techniques to find that increasing the number of positive tweets increased the sales of video games by approximately four times that of increasing non-Twitter advertising by the same amount.

In the case of world leading digitalisation almost all firms have a website and the majority are making use of social media to connect with customers. This enables smaller firms to access potential customers more easily and advertise to them in a potentially more efficient manner. By being able to increase demand for their goods and services, firms will be able to expand and this will allow them to employ more people. However, lower levels of digitalisation amongst firms will reduce the potential business opportunities for smaller firms and thus fewer people may be employed.

Using e-commerce also has the potential to generate time saving benefits for people because they do not have to travel to the shops and it may also be quicker to shop online than in store. As an indication of the economic benefits from time savings through e-commerce, doing the weekly grocery shop and other online purchases are used as examples:

Doing the weekly grocery shop online reduces travel time for the individual as well as potentially saving time through having pre-selected options that are bought on a weekly basis. Based on the average distance to the shops from the National Travel Survey and the value of non-commuting travel time used by the Department of Transport, if 20% of households do their weekly shop online then the value of the saved time from travelling to the store is £125m, with over half of the benefit being in rural areas.

Other online shopping is also likely to save journey time as people get products delivered to their homes or to a convenient location. As an indication of the potential benefits of time saved, if adults in Scotland buy two more products online per month instead of travelling to the shops then the value of the time saved could be £530m, with slightly over half of the benefit being in rural areas.

3.4 Other economic impacts

Exports

Scottish exports in 2013 accounted for 22% of GDP, excluding oil and gas revenues. Improved productivity and opportunities to extend the marketplace via online advertising platforms can increase the competitiveness and the attractiveness of Scottish goods and services both home and abroad, with likely increases in the demand for Scottish goods and services. While the change over time of the mix of exports is complex to predict, with Scotland's current export focusing on oil, spirits, food such as meat and fish, and financial services, based on today's share export/GDP, then exports could increase by more than £2.5bn in an advanced digitalisation scenario and £2.1bn in a world class digitalisation scenario compared to the counterfactual. This would represent cumulative increases of nearly £22bn and £16bn respectively.

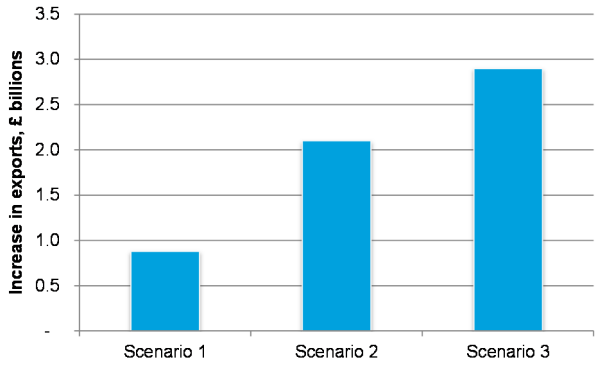
Based on the 2011 Input-Output tables, Scotland exports approximately £2bn of computer equipment and computer services. Enhanced digitalisation may enable an increase in the exports from this sector as well as making it easier for other sectors to export through improved competitiveness and access to a broader market through the use of the internet.

A sector that may be impacted through increased digitalisation is tourism. Overnight tourists in Scotland spent £4.6bn in 2013 with 36% of this coming from outside the UK.[56] Increased digitalisation will enable people to access information about different tourist activities beyond the more traditional tourist sights. This would enable visitors to experience a more rounded experience, which is an area of development in "Tourism Scotland 2020".[57] Improved access to information may also improve the standards of accommodation as people are able to better judge the quality before booking.

Other important sectors that may be affected by the adoption of new technologies are financial services, benefitting from increase connectivity and easier access to banking apps; and energy and life sciences, e.g. through IoT applications such as smart meters.

[56] http://www.visitscotland.org/pdf/VS%20Insights%20Key%20Facts%202013.pdf
[57] http://scottishtourismalliance.co.uk/wp-content/uploads/2013/03/Scottish-Tourism-Strategy-TourismScotland2020.pdf

Figure 39: Total increase in exports, 2030

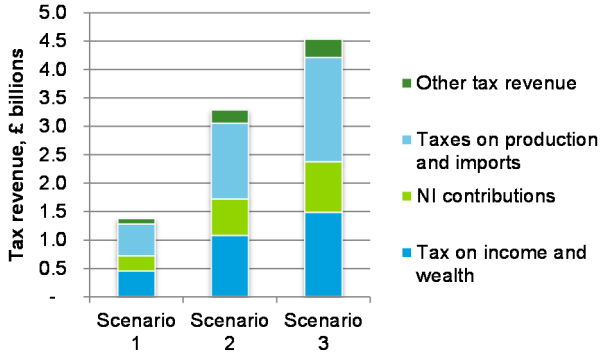


Source: Deloitte analysis

Taxes

Increased economic activity generated by digitalisation can also increase the tax revenue generated by Scotland. Considering today's tax revenue structure and tax revenue as a proportion of GDP as a basis for an estimate, and recognising that a proportion of these taxes accrue to the national governments and only a part goes directly to the Scottish Government, it is estimated that in Scenario 3 up to an additional £4.5bn per year by the end of the period could be added in tax up from £3.2bn in Scenario 2. This is compared to a fiscal deficit in Scotland in 2013-2014, including capital investment and a geographic share of North Sea revenue of £12.4 billion.[58]

Figure 40: Increase in tax revenues generated in Scotland



Source: Deloitte analysis

Poverty and inequality

Reducing inequality and relative poverty in Scotland is a high priority for the current Scottish Government. In 2012/13, relative poverty, defined as someone in a household earning less than 60% of the UK median disposable income, was 16% before housing costs and was slightly higher in urban areas compared to rural areas (15%). This represented an increase of 2 percentage points on the previous year and reverses a trend of falling relative poverty since 2002. There is also evidence that incomes of those in poverty are not increasing in line with inflation.[59] As noted above, those in relative poverty are also associated with lower internet penetration rates.

Enhanced digitalisation can help reduce poverty through job creation resulting from economic growth: evidence from the UK shows that job creation appears to be more important for reducing relative poverty than economic growth, with a proven link between cities with the highest increases in employment and those that are most successful in reducing poverty.[60] Reduced poverty can then have a positive effect on economic growth through higher incomes, more efficient use of skills and reduced welfare spending. Internet access can also increase access to education and resources as well as potentially improving the quality of education which can improve people's employability. The ways in which education and digital participation can also help reduce poverty are discussed in the next section.

[58] http://www.gov.scot/Publications/2015/03/1422
[59] Scottish Government, Scottish poverty statistics summary briefing, December 2014
[60] Joseph Rowntree Foundation, Cities, Growth and poverty: Evidence review

Under the scenario of world class digitalisation, the extra jobs and income generated through enhanced digitalisation and the extra economic activity it generates throughout the economy may have a significant impact on poverty should those in poverty access some of the additional jobs and receive a higher income. The extra tax revenue generated by enhanced digitalisation could also be used to improve the incomes of those in poverty or to improve the poor's access to these jobs through training. Whilst a high level of digitalisation may be able to significantly impact the levels of poverty in Scotland, a slight improvement in the level of digitalisation is likely to have a far smaller impact due to fewer jobs and less tax revenue.

Whilst analysis has been undertaken on the impacts of internet penetration on absolute poverty in developing countries, the impact of internet penetration and digitalisation on relative poverty in developed countries remains an area where more research could be undertaken.[61]

3.5 Public sector impacts

The economic benefits to the public sector of enhanced digitalisation derive, as with businesses, from the cost savings and efficiencies from incorporating digital technologies in public administration and providing services online.

In the same way that cloud computing can reduce ICT costs for businesses, cloud computing can reduce costs for government departments and agencies. For example, a report looking at the implementation of cloud technology in US government departments and agencies found that it reduced IT related expenditure by 25%-50%.[62] This report finds that using cloud computing can save the public sector money through achieving a higher utilisation of data centres, resulting in fewer servers being used, and increased infrastructure flexibility, which can allow the usage to be scaled up or down depending on the level of traffic. This cost saving depends on factors such as whether the cloud is a public cloud, a private cloud or a hybrid. By increasing the amount of government departments using the cloud, the report found that the US government could save billions of dollars.

A recent review into the ICT infrastructure in the public sector found that £1.4bn was spent on ICT by the Scottish public sector in 2010. Under a scenario of full digitalisation with potential yearly benefits of over £230m through better coordination across the public sector. In addition, the adoption of digital technologies may result in productivity improvements across the public sector.

Interoperability can also result in benefits relating to an increasingly joined up civil service. For example, in South Korea the civil service has a digital budget and accounting system which allows government activities to be managed on a real-time basis as well as providing statistical and analytical information. Information sharing within the government can improve the efficiency of government and public services as well as enabling more informed decision making.[63]

Providing online public services is also likely to result in cost savings as well as making it easier for many to access the services. Traditional "face-to-face" enquiries can cost up to £11.28 whereas an equivalent enquiry could cost £6.35 in a contact centre of just 46p if it is online.[64] The Scottish Government is currently working on an online portal to allow citizens and businesses to access online services. Discussions with market participants suggest that the majority of the progress has been at the local council level. One example is Renfrewshire Council which is saving £10m per year through modernising its public services using digital technologies.[65] As digitalisation increases in the scenarios a greater number of people are using more online services, which could lead to a significant cost saving. In a world leading level of digitalisation the government moving into smart government would allow people to interact with the government anytime and anywhere. Examples include real-time public safety services and reporting faults with public infrastructure.

A more detailed discussion of public healthcare cost savings associated to enhanced digitalisation is included in Section 4.

Smart Cities

A "Smart City" is one where public authorities use IoT devices and other ICT technologies to improve the quality of public services and other areas. Currently smart city applications focus on transport, environment and energy, municipal projects such as waste management, and economic stimulus and open data projects such as the App Development Centre in Busan, South

[61] Internet.org, Value of Connectivity: Economic and social benefits of expanding internet access
[62] Darrel West, 2010, Saving Money through Cloud computing
[63] United Nations, e-Government of Korea: from policy to practice
[64] John McClelland, Review of ICT Infrastructure in the Public Sector in Scotland.
[65] John McClelland, Review of ICT Infrastructure in the Public Sector in Scotland.

Korea, with the aim of the City of Busan co-creating smart city services with start-ups. In its first year it established 13 companies and developed 70 apps. [66]

These initiatives can also improve the efficiency of public services. Across the scenarios of digitalisation, the government increasingly uses a large number of internet connected devices in order to share information on traffic, parking spaces, reduce energy use through smart metering, and improve water and waste management. As well as improving the provision of public services, such as knowing when to collect full bins which can reduce costs and rubbish on the streets, smart city applications can improve the environment in which people live. These devices also generate a large amount of data. Opening up some of this data to interested parties can encourage innovation, better services and new businesses.

Figure 41: Potential environmental benefits from smart cities

Amsterdam's Climate Street programme has connected electricity meters to match supply and demand and connected rubbish bins so the waste is only collected when the bins are full. This has reduced the annual CO_2 emissions in a shopping area from 3,400 tonnes in 2010 to 1,276 tonnes in 2012.

Source: GSMA, Guide to smart cities

Figure 42: Benefit to public services of smart cities

Madrid introduced a new communications system for the fire service, police, paramedics and its traffic management service that integrates information provided by all the services to provide a complete view of the incident which can be accessed by the emergency services on the move. This has enabled faster and improved decision making, reducing the average response times of the emergency services by 25%.

Source: GSMA, Guide to smart cities

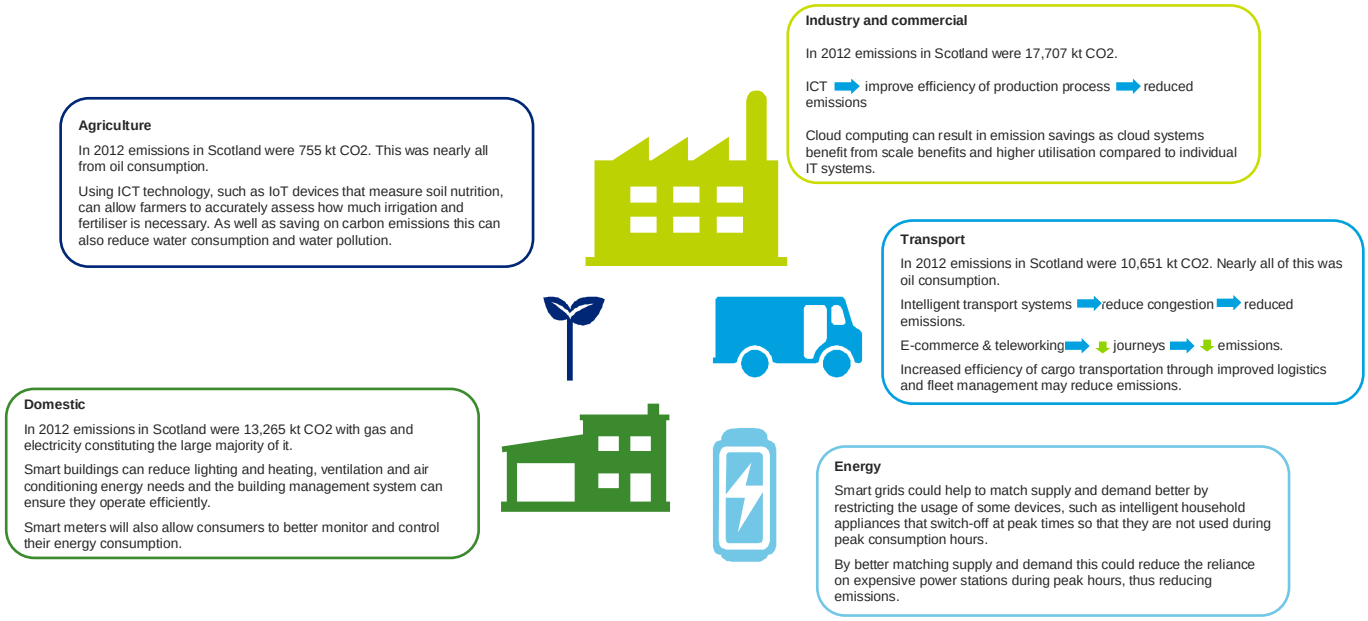
3.6 Environmental impacts

A key facet of more efficient and productive economic activities driven by digitalisation is given by the environmental impacts of new digital technologies and their widespread usage.

Whilst Scotland has outperformed the rest of the UK in cutting its CO_2 emissions, and has a target of cutting emissions by 42% from 1990 levels by 2020 with an 80% reduction required by 2050, it has failed to meet its targets for the past three years. [67] Increasing levels of digitalisation may be able to contribute to a significant fall in emissions and help Scotland meet its targets. Environment improving applications of devices are possible in industry and agriculture, the home, transport and in energy distribution. As the use of connected devices is a common method of reducing emissions, it is likely that the largest benefits will occur if Scotland is a world leader and has over 120 million IoT devices and nearly all firms using cloud computing.

[66] GSMA, Guide to Smart Cities
[67] http://www.scotsman.com/news/environment/scotland-fails-to-hit-target-on-carbon-emissions-1-3439870

Figure 43: Environmental environments of digitalisation



Source: Ricardo-AEA, "Local and Regional CO2 Emissions estimates for 2005-2012" and GESI Smarter 2020

3.7 Displacement effects

ICT and digitalisation can have a significant impact on traditional business models and supply chains, and boost the productivity of workers. This has the potential to transform markets and the way in which companies and consumers connect, with the potential to alter the competitive landscape in an industry. While many businesses capitalise on the opportunities afforded by the ICT benefit, some of this benefit can come at the expense of other players in the market. This section reviews possible displacement effects in Scotland due to the increased use of information and technology across society.

The uptake of digital technologies has the potential to widen the business outcomes between those firms that digitalise their operations than those that don't. Those companies that switch to digital operations can achieve cost reductions, reach new markets, and create new jobs and services such as apps. As an example, publishing companies that shift online can substantially lower their costs and reach more readers. Those businesses that do not digitise may therefore suffer due to reduced competitiveness or find that the digitalisation in their industry has reduced their role, as is the case for intermediaries in some markets whose role is reduced as a result of higher flows of information. The relative impact of the additional businesses created by the internet and the various new opportunities it creates compared to those displaced, still remains a point of debate.[68]

In addition to the impact on businesses, digitalisation can have an impact on jobs through improved productivity, reducing the number of employees required to deliver a service. According to the industry literature, the balance between the job losses due to improved productivity and the increased business opportunities and innovation created through enhanced digitalisation is likely to result in a net gain in jobs. Recently, a study undertaken in France finds that over the past 15 years, the internet created 2.4 jobs for every one job that it destroyed in the French economy.[69]

As Scotland becomes increasingly digitalised over time, a transformation of economic activities is to be expected, which would be greater under a full digitalisation scenario. While this may create losses to some players and jobs, the transformational potential and the benefits delivered to consumers are likely to be higher than the losses. Additionally, key to considering these impacts is also the implied costs that Scotland could face if digitalisation is not fully exploited: this could include a loss in competitiveness with more efficient foreign companies and economies, with long term potential for disruption.

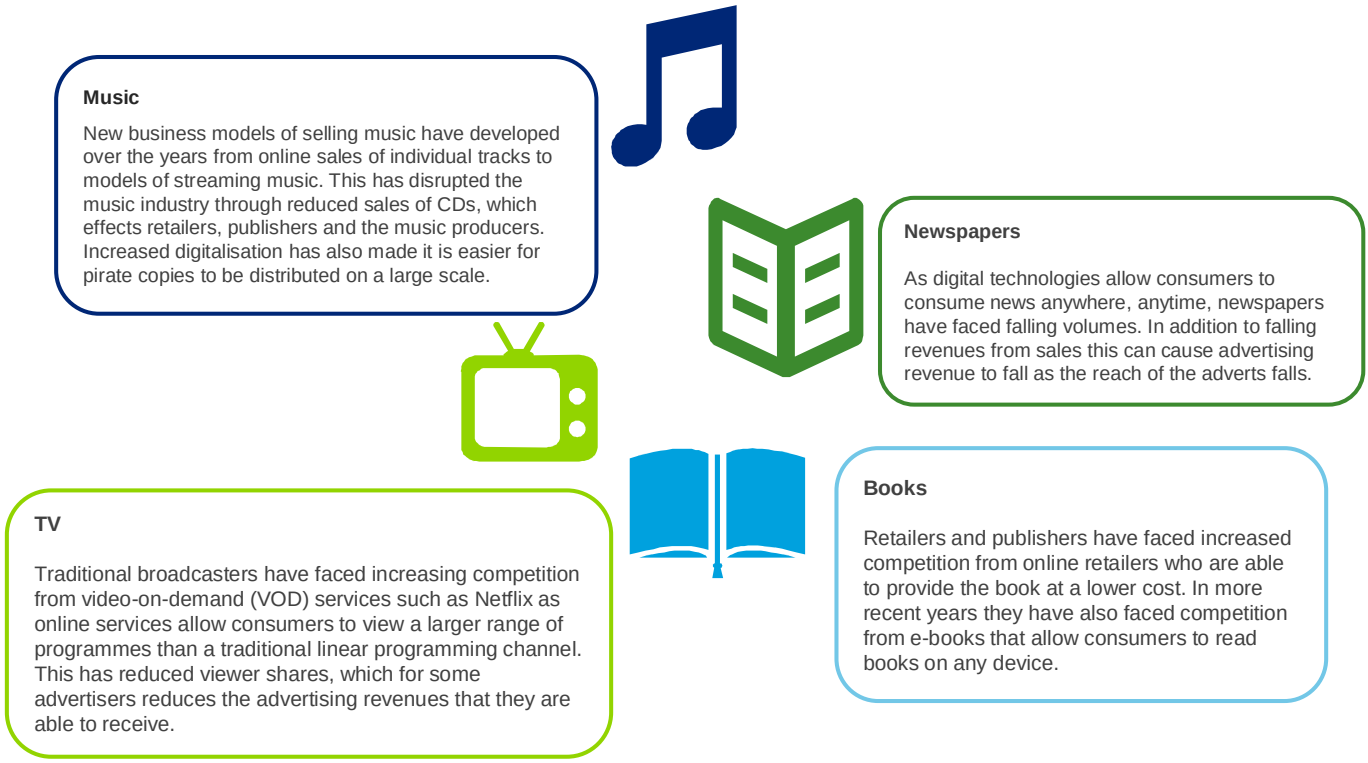
[68] UK broadband impact study, SQW (2013)
[69] Internet matters, McKinsey Global Institute

Based on recent experience in Europe and the US, a selection of industries that may experience displacement effects due to enhanced digitalisation are discussed in this section, along with ways in which these industries can adapt and benefit from digitalisation.

Media

The media industry – including newspapers, music, TV and books - has traditionally seen high displacement due to the internet and digital technologies (Figure 44). This sector has generally been performing robustly in Scotland. Over 100 production companies (including animation and film) and more than 300 facilities companies in Scotland generate a turnover of $1.7bn per year. Broadcasting and film have a lengthy history that digital technology is set to impact.[70]

Figure 44: Displacement impact of ICT in media



In a scenario where small and medium firms do not have access to new technologies, displacement of employees and business is a concern. However, media and entertainment industries in Scotland are a good example of how this threat can be turned into an opportunity. Scotland has a digital strategy focused on the areas of broadcast, games and digital publishing, with an objective to employ mobile technologies to advance these sectors. In 2011, the digital media sector in Scotland already employed over 42,000 people and contributed $4.93bn annually to the country's economy.[71]

A survey of firms by IBM and the Economist Intelligence Unit found that media and entertainment businesses are generally embracing new technologies more than the average firm.[72] One such example is the use of cloud technology. This is particularly relevant in a world where people are consuming more media and entertainment on their smartphones, which do not store much data. By embracing cloud technology these firms are able to increase the reach and availability of their content as well as increase collaboration with external partners and create new revenue streams.

[70] Introduction to digital media in Scotland, Scottish Development International
[71] Introduction to digital media in Scotland, Scottish Development International
[72] IBM Institute for Business Value, Leveraging the Cloud in media and Entertainment

Figure 45: Embracing digital in news distribution

Faced with a shrinking market for print media, the Guardian increased its digital presence. This has enabled it to substantially increase its readership and enter new markets, such as the USA, in which it didn't have a print business.

The Guardian has increasingly become a digital organisation, with Guardian News & Media prioritising digital. This has involved the development of apps for different platforms and having open platforms for journalism. The Guardian has also expanded its readership by using digital platforms to launch editions in the US and Australia and has readers in many countries across the globe. In September 2014 they reported traffic of 114 million monthly unique browsers.

Source: http://www.theguardian.com/gnm-archive/guardian-website-timeline

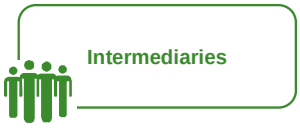
The retail sector is another important sector for Scotland where digital technologies have the potential to transform business models and the market. One survey shows that since 2010, consumers spend more time shopping online: up by 18% of people compared to a 14% fall in shopping via intermediaries.

The retail sector in Scotland and the UK is stronger compared to other European countries. The sector contributes around 5% of Scotland's Gross Value Add, 10% of its turnover and 10% of its employment.

As the internet connects suppliers with consumers directly, the retail business in Scotland may require a transformation. Price comparison websites are increasingly common and these can open retailers up to more competition through improved information for consumers. Selling to consumers online can be cheaper than traditional brick-and-mortar retailing because of the reduced building space required which allows online retailers to offer more competitive prices. This is combined with lower search costs for consumers when shopping online and an increased range of products available to them.

At the same time a potential opportunity that the internet presents to retailers is the so called "omni-channel marketing". This is where a retailer has both a physical presence in the form of shops and an online presence. This allows people to acquire information online, benefit from the pre-sales experience of testing the product and then decide where to buy it. This is highlighted by a survey undertaken by IBM, which shows that although more consumers get their information online (95% versus 92% of people); the large majority of purchases are still in person rather than on websites (61% versus 27%).[73]

The benefit of omni-channel retailing to retailers has been measured in a report by Deloitte for eBay. This report found that 95% of online sales are incremental sales for those retailers that provide both online and in-store sales. This shows that rather than being substitutes for these firms, online sales can complement in-store sales.[74] Additionally, the survey conducted for this study found that 25% of online shoppers could not have bought their products in their local store, which highlights' how having an online presence can also increase the size of the market.



Intermediaries connect consumers to suppliers and often make comparisons for the consumer to inform their decisions. An example of sectors where digitalisation has affected this traditional relationship is the impact of the internet and comparison websites on insurance brokers and travel agents.

Prior to the widespread adoption of the internet, insurance brokers were present on many high streets. However, the internet has facilitated online price comparison websites that increase the transparency of the market and reduce the need to use a broker to select the best policy as the customer can do that directly. Additionally, customers can visit directly the website of the insurance provider.[75] Whilst travel agents are still common on the high street, online comparison websites and consumers being able to put the package together themselves has increased the competition that travel agents face.

[73] http://insights-on-business.com/insurance/digital-reinvention-and-the-role-of-the-intermediary/
[74] Deloitte, 2014, The omnichannel opportunity: Unlocking the power of the connected consumer
[75] IBM, Digital reinvention: Trust, transparency and technology in the insurance world of tomorrow

Price comparison websites have a competitive advantage in acting as a broker and agent due to not needing to pay fixed costs required for a brick and mortar operation. This lower cost allows them to charge a lower commission and hence be more competitive. Price comparison websites also have an advantage over phone brokers due to reduced labour costs enabled by automation. The generally lower price of purchasing insurance online has resulted in many people using price comparison websites instead of the traditional brokers. However, it is worth noting that traditional brokers and travel agents do have the advantage of being able to act as advisors and not just finding the best deal available.

Going forward there is further potential change in the market due to social media allowing people to discuss the insurers and other digital technologies such as IoT and cloud computing allowing for more personalised services. While this could present a challenge to the insurance industry, this also presents an opportunity to offer new services, such as individual insurance networks that allow people to reduce their premiums significantly.

4 The social impacts of enhanced digitalisation

From improving the provision of services such as healthcare and education to enhancing social mobility and increasing civic participation, the internet has already transformed society. Enhanced digitalisation in the future has the potential to scale these improvements to a larger population. At the same time, increasing digitalisation can create new services across a series of social activities.

This section discusses the impacts of enhanced digitalisation on three areas: healthcare services, education provision and digital participation in Scotland.

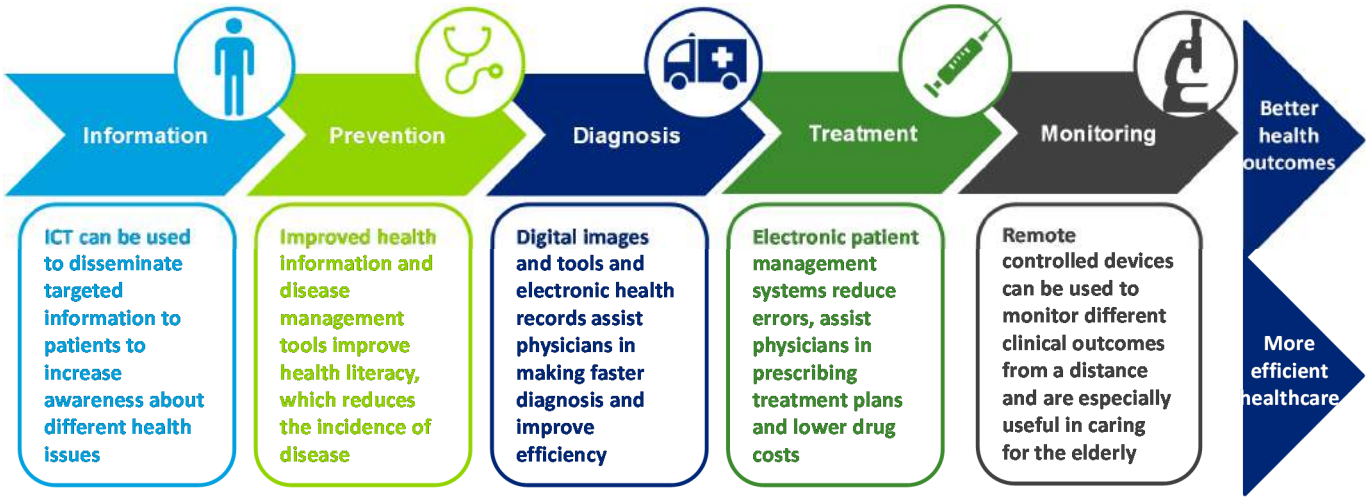
4.1 Impacts of enhanced digitalisation on healthcare

Information technology is increasingly being deployed in the provision of healthcare. Digitalisation can assist in addressing the main health issues faced in Scotland, such as an ageing population. It can also help in transitioning to a system of continuous and integrated care, where healthcare and social care systems are fully coordinated and patients have access to care anytime and anywhere.

EHealth, which is the use of information technology in the health sector, has the potential to impact almost every element of healthcare provision (see Figure 46). Access to the internet can improve health conditions by reducing the incidence of diseases through better information for both patients and health practitioners. In addition to extending access to medical information, mobile and internet technologies have the potential to improve medical behaviours for patients and healthcare professionals by releasing doctors' time through reduced travel and increased efficiency, reminding individuals of their due treatments or medications, and providing easy access to information and enabling connectedness between patients and doctors, and between doctors in different locations. This has clear benefits for the delivery of medical services.

EHealth can lead to improved health outcomes such as reduced mortality, fewer hospital admissions and a more health aware society. It can also lead to a variety of cost savings, from reducing laboratory test costs to saving time by automating many processes, and hence improve efficiency.

Figure 46: Impacts of eHealth across the healthcare service chain



Source: Deloitte analysis

4.1.1 EHealth in Scotland today

EHealth has been a major focus of the UK and Scottish Government's health strategy over the past few years, as evidenced by increased digitalisation in the National Health Service (NHS). The guiding framework for eHealth in Scotland is the government's eHealth strategy 2011-2017. Rather than focusing on specific products or technologies, this strategy aims to put the citizen at the centre of health care delivery by improving their experience with NHS Scotland. It aims to do this by providing better information to patients and health workers, by supporting people to become active participants in their own care and by integrating different kinds of care services across the health and social services sector more effectively.[76] By providing continuous care in and out of the hospital, eHealth can enable these effects.

According to the Scottish Government's health strategy, the ageing population is a main concern going into the future. Currently, the proportion of those aged 65 and above in Scotland is about 18%, and it is expected to become roughly 23% by 2030.[77] The elderly use a higher amount of health resources; they are more likely to be admitted to hospital, have complex medical problems and are more likely to have chronic conditions. Due to Scotland's changing demographics, the government has various programmes to provide quality care to older people, such as The Reshaping Care for Older People initiative. Telecare is also currently being used for this purpose but its use is limited, with only about 100,000 people in Scotland having access to it.[78]

More widespread adoption of eHealth by the government and patients can be made possible by increasing internet and device penetration in Scotland. In a survey of European hospitals presented at the 2014 EU Summit on Chronic Disease, the UK was below the EU average on eHealth availability and use.[79] Given the evidence on how eHealth can lead to improved health outcomes and efficiencies, increased digitalisation has the potential to help Scotland achieve some of its health targets.

4.1.2 Increased digitalisation and health outcomes

As Scotland moves from today's levels of digitalisation to increased access and use of technology, implementation of eHealth and its impact on health outcomes increases. With increased internet and smartphone usage, access to health related information increases, making people more health literate. This has the potential to reduce the mortality rate and improves the quality of life across the three scenarios. Furthermore, in scenarios where Scotland is a world leader in digitalisation more advanced eHealth features such as clinical decision support tools become available. These support physicians and patients in managing treatment plans and reduce the number of preventable deaths.

Three main channels through which enhanced digitalisation impacts health outcomes discussed are:

- Impact of enhanced digitalisation on health literacy and illness prevention.
- Impact of electronic patient management systems on patient experience and quality of life.
- Impact of telemedicine on the quality of health provision to the elderly and those with chronic disease.

These impacts are presented incrementally for different levels of digitalisation. In a scenario of incremental digitalisation, there is some improvement in transitioning to a paperless NHS and a limited number of physicians and practices have access to remote consultation technologies. In a scenario of more enhanced digitalisation, electronic health management systems with some interoperability are present and remote consultation infrastructure is in place for most institutions. In a scenario where Scotland is a world leader in digitalisation, there is seamless interoperability between different IT systems and remote consultation facilities are in place for everyone who needs them.

Impact of enhanced digitalisation on health literacy and illness prevention

Health literacy is the ability to obtain, understand and use information to make appropriate health decisions and follow treatment instructions. It is different from literacy, which is generally defined as the ability to read and write. Health literacy is about people having the knowledge, skills, understanding and confidence to use health information, to be active partners in their own care, and to navigate health and social care systems.

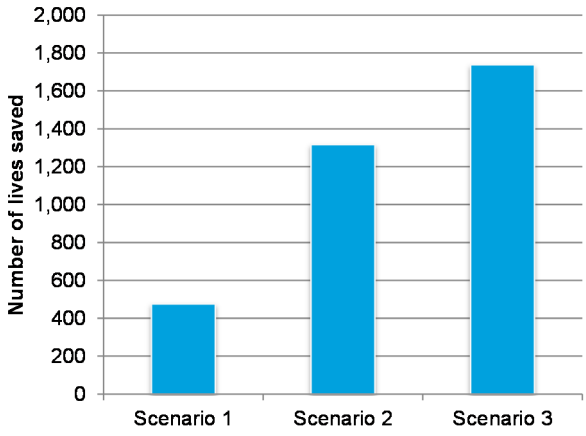
[76] The eHealth Strategy for NHS Scotland 2011-17
[77] Population projections for Scottish Areas, National Records of Scotland
[78] Reshaping Care for Older People Audit 2014
[79] Benchmarking Information and Communication Technologies in Health Systems, April 2013, EU-OECD Workshop

Scotland's Health Literacy Action Plan indicates that today 27% of adults have difficulties in day-to-day reading and numeracy. Furthermore in a sample of eight European countries, almost half of the population had inadequate levels of health literacy.[80] This implies that even in advanced developed countries with high levels of literacy, health literacy levels can be below desired levels.

More widespread penetration of internet and mobile devices can help to improve health literacy. They make information more readily available to anyone who wants to access it. This information is accessed through websites, smartphone applications and online communities of peers. In the context of the digital scenarios, in Scenario 1 the majority of the population accesses websites for health related information. In Scenarios 2 and 3, more people use smartphone applications for customised health plans and online health communities also become more prevalent. Given the link between internet penetration and health literacy, we expect health literacy to increase across the three scenarios. In a scenario with incremental improvement in internet penetration, about 83% of the adult population can be assumed to be health literate while in a scenario where almost everyone has internet access perpetually almost the entire population can be health literate.

A number of studies consider the link between health literacy and lives saved. One study published in the British Medical Journal (BMJ), finds that in a sample of 8,000 adults from the UK those with low health literacy were 26% more likely to die in a given year compared to those with high health literacy, while those with medium health literacy were 7% more likely to die.[81] These results can be explained by the well-established link between high health literacy and improved health outcomes – people with better health literacy are more likely to take preventive measures such as mammograms and flu shots, have lower rates of hospitalisation and report better health status.[82] In Scenario 1, around 93% of the population uses the internet and health related information is mostly accessed via websites, which leads to an incremental improvement in mortality. These results have been used to provide a measure of the lives saved across the three scenarios due to improved health literacy.

Figure 47: Number of lives saved due to improved health literacy in 2030[83]

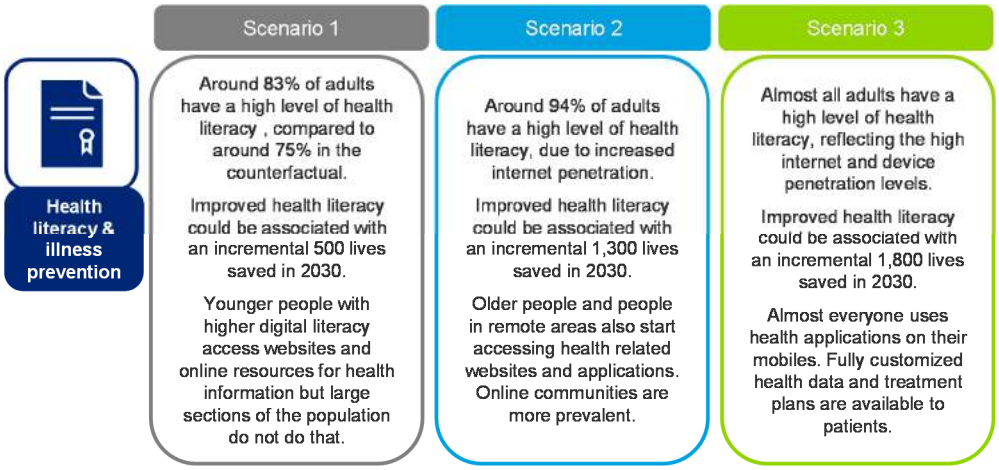


Source: Deloitte analysis

Expanding these results to Scotland using mortality rate and population projections published by the government, it is estimated that in a scenario where almost everyone is health literate about 1,800 additional lives can be saved in the year 2030 compared to the counterfactual.[84] Given that Scottish Government projections indicate about 50,000 deaths in Scotland in 2030, this amounts to more than a 3% reduction in mortality.[85] In scenarios with lower penetration rates, about 1,300 (Scenario 2) and 500 (Scenario 1) lives can be saved (see Figure 47).[86]

[80] Health Literacy Action Plan for Scotland, 2014
[81] Association between low functional health literacy and mortality in older adults: longitudinal cohort study, BMJ (2012)
[82] http://www.health.gov/communication/literacy/quickguide/factsliteracy.htm
[83] For those aged 52 and over
[84] The numbers provide an indication of the lives saved in the year 2030; the cumulative impact is likely to be higher
[85] The figures only include deaths in those aged 52 and above because the study considered that age group. About 95% of all deaths are projected to be among this age group.
[86] Proportion of health literate population in the counterfactual is 77%

Figure 48: Impacts of enhanced digitalisation on health literacy and illness prevention



Source: Deloitte analysis

An example of the way websites can improve health literacy is the my diabetes, my way website in Scotland; it helps diabetes patients to manage and learn about their disease.

Figure 49: Website for diabetes management and education in Scotland

There are over 250,000 people with diabetes in Scotland – this amounts to one person in every 20. ***My diabetes, my way*** is the NHS Scotland interactive diabetes website to help support people who have diabetes and their family and friends.

It has leaflets, videos, educational tools and games containing information about diabetes. It can also be used by patients to view their up-to-date diabetes clinical results and to manage their condition in general. It provides customised information to patients depending on their condition and test results, explains the different results and keeps a record of a patient's clinical outcomes over time.

Source: http://www.mydiabetesmyway.scot.nhs.uk/

Smartphone health applications are already in use in Scotland but they become more prevalent in Scenarios 2 and 3 (the average number of smartphones per person reaches 1.5 in Scenario 3). In 2012, NHS England introduced its Health Applications Library - a repository of smartphone applications that consumers can download to manage their health.[87] It hosts a wide range of applications that have been reviewed by the NHS to ensure they are clinically safe. These range from applications that help to manage specific conditions, such as dementia or cancer, to those that promote generally healthy lifestyle choices. As smartphone penetration increases across the scenarios, the use of such applications also increases, improving health literacy and health outcomes.

Figure 50: SIGN, a medical application for smartphones

According to the BBC, an app for smartphones and tablets designed by the Scottish NHS is one of the most popular free medical apps available for download. The app, which goes by the name of SIGN, was launched in 2011 and downloaded more than 8000 times within a few months of its launch.

It outlines the kind of care patients should expect when they suffer from particular medical conditions. It offers guidelines on a wide range of conditions such as rheumatoid arthritis, eczema, diabetes and the management of asthma and psoriasis.

Patients and doctors can both access NHS guidelines on any condition using this application. This facilitates more informed discussions between doctors and patients.

Source: BBC News

[87] http://apps.nhs.uk/

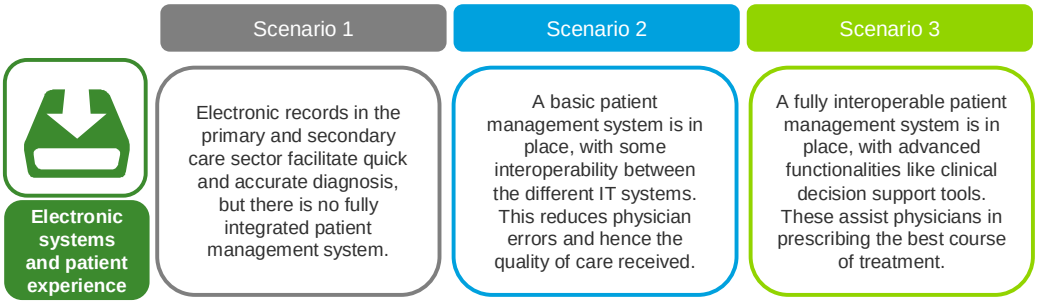
Impact of electronic patient management systems on patient experience and quality of life

Information technology can be employed in the health sector to transition from manual patient and administrative records to electronic databases and patient management software. These save time, reduce errors by physicians and deliver improved service to patients.

Scotland has already started transitioning to electronic patient records. Currently, general practitioner (GP) practices use electronic patient records. These records are also used to create an Emergency Care Summary (ECS) for every person in Scotland, which is readily accessible by a physician in case of an emergency. A clinical portal aimed at the secondary sector is still being rolled out nationally.[88]

In a scenario of incremental digitalisation (such as Scenario 1), basic electronic records would be in place in both the primary and secondary sector, including a fully functional clinical portal. However, there would be limited interoperability between different systems. This implies that physicians and community health workers would save time spent in collecting manual records and serve patients faster but the full benefits of digitalisation would not be realised.

Figure 51: Impact of electronic records on patient experience



Source: Deloitte analysis

In scenarios of more enhanced digitalisation, more or near perfect interoperability between different IT systems would be achieved. Interoperability would allow different databases and IT systems to exchange information. This means, for instance, that a patient's records can automatically update the results of a laboratory test once it has been performed. Such interoperability ensures that records are complete, up-to-date and reliable. It also ensures that patient information stored in different databases can be accessed by anyone and any time as required, and hence improves the patient experience of clinical care. An example of a healthcare system that has successfully transitioned to becoming almost paperless is that of Denmark (see Figure 52).

Figure 52: Digital exchange of health data in Denmark

Denmark is currently a world leader in eHealth. It established MedCom in 1994, a platform facilitating digital exchange of health data. It developed nationwide communication standards for the most common messages between public hospitals and general practitioners as well as private companies linked to the health care sector, e.g. pharmacies.

From a rather slow start with less than 4,000 documents in the first year, the exchange of health care documents is now almost fully electronic with more than 60 million messages sent in 2011. In reality practically all frequent documents in the health care sector are transferred electronically between health care professionals, saving time and money and facilitating quick decision making.

Source: A Vision for eHealth in Denmark

Under Scenario 3, where information technology is common across the health sector, it would be expected that the use of more advanced functionalities of patient management systems, such as clinical decision support tools, be widespread. These assist patients and physicians in creating and following treatment plans. For physicians such systems have a number of functionalities: they alert a physician to allergies that a patient has, they can point out potential drug interactions in a treatment plan and they can also indicate if a certain test is redundant or if a cheaper alternate to the medicine being prescribed is available. For

[88] Source: health experts from the Scottish Government

patients, they can help in following treatment schedules properly. They can provide customised, updated and easy to understand information and reminders about a patient's care routine. Hence, they can significantly improve a patient's healthcare experience.

Figure 53: Trial of clinical decision support tools in Canada

The province of British Columbia in Canada employed a chronic disease management toolkit in 2001, in order to improve the care provided to patients with chronic disease. The system had decision support tools, such as flow charts, and also allowed health professionals to monitor and evaluate the care provided to patients.

An evaluation of the system indicated that a relatively modest investment in IT had led to a rapid improvement in diabetes care in the province. Compared to baseline data, the proportion of people with diabetes who underwent tests complying with proper clinical guidelines, increased from 22% to 49% over a four year period.

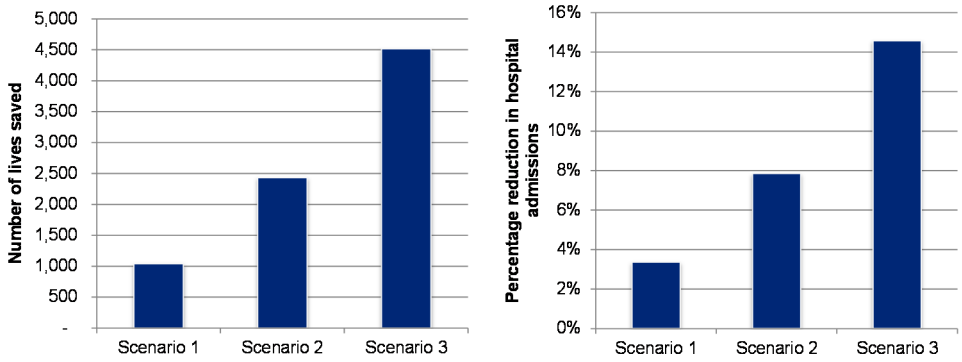
Source: Improving health sector efficiency: the role of information and communication technologies, OECD 2010

Telemedicine and Telemonitoring

Telemedicine is the use of information technology to provide clinical care from a distance. Because consultations can happen online and test results can also be communicated electronically, telemedicine reduces the number of in-person appointments and allows physicians to prioritise which patients they see in person.

According to the Scottish Government's eHealth strategy, developing telemedicine and telecare are priority areas for the government. These services facilitate the provision of a system of integrated care – that is coordinated care provision across hospitals, the social care sector and in the community. They are also important in keeping older people in their homes for care provision – one of the aims of Scotland's Reshaping Care for Older People strategy.[89]

Figure 54: Impact of telemedicine on the number of deaths and hospital admissions from chronic illness



Source: Deloitte analysis

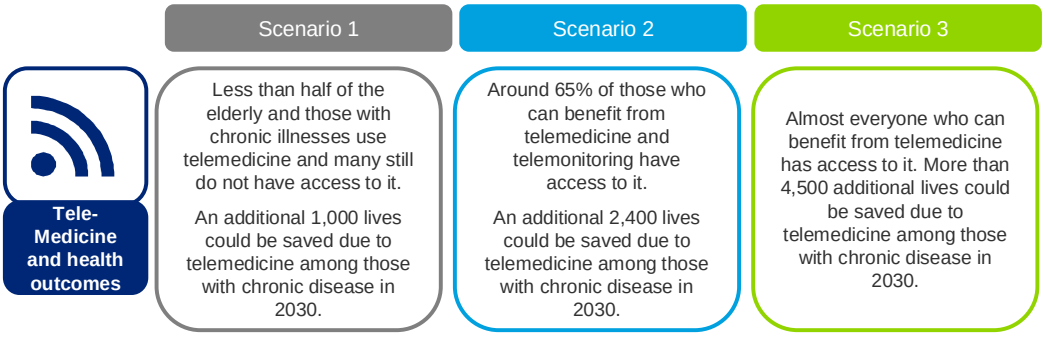
Telemedicine can be useful in providing care to the elderly and to those with chronic disease, both of which are major health concerns for Scotland. Currently, 40% of Scotland's population has a chronic disease and 60% of all deaths in Scotland are caused by chronic conditions.[90] Given the prevalence rate of chronic illnesses and the population projections of Scotland, over 2 million people would be expected to have some kind of long term condition by 2030.[91] In a scenario with incremental digitalisation, less than half of these people will have access to telemedicine by 2030, compared to about 65% having access in Scenario 2 and nearly everyone having access in Scenario 3. This would mean that in a scenario where Scotland is a world leader in digitalisation (Scenario 3), an additional 1.5 million people with chronic illnesses would have access to telemedicine in comparison to the counterfactual.

[89] Reshaping Care for Older People, Audit Scotland 2014
[90] http://www.gov.scot/Topics/Health/Services/Long-Term-Conditions
[91] Using population forecasts and prevalence rates published by the Scottish Governmentgovernment

These assumptions have been used to provide an estimate of the number of deaths and hospital admissions from chronic illness across the three scenarios. Several studies show that telemedicine can improve health outcomes among those with chronic diseases.[92] The study employed here reviewed the results of 14 clinical trials to determine whether remote monitoring, including structured telephone support and telemonitoring as a substitute for clinic and home visits, can improve outcomes in patients with chronic heart failure. It found that remote monitoring reduced the rates of admission to hospital for heart failure by 21% and mortality rates by 20%.[93]

Using this study, mortality rate projections and hospital admission data published by the Scottish Government, it is estimated that an additional 1,000 deaths from chronic illness can be prevented in 2030 in a scenario of incremental digitalisation. This is in comparison to a counterfactual where around 30% of people with chronic illness have access to telemedicine and telecare. In Scenario 2 and 3, approximately 2,400 and 4,500 additional lives can be saved respectively. Similarly, a reduction is hospital admissions due to chronic disease of 3%, 8% and 15% is possible across Scenario 1, 2 and 3 respectively (cost savings due to reduced hospital admissions are discussed below).

Figure 55: Summary impacts of telemedicine on health outcomes



Source: Deloitte analysis

In addition to the reduction in mortality rates and hospital admissions, six trials examined in the same study also considered the effect on health related quality of life and acceptability of the intervention to patients. Most of these trials reported the intervention to be acceptable to patients and to improve their quality of life. Employing telemedicine to care for more people with chronic illnesses can therefore lead to longer life expectancy and quality of life among these people across the three scenarios.

Telemedicine is not only useful in caring for those with chronic disease but in caring for the elderly in general. This is because it can provide quick care and feedback from a physician while keeping the elderly in their homes. A greater proportion of the elderly have access to telemonitoring and telemedicine across the three scenarios, compared to the 100,000 that have access today. This results in higher quality health care for these people across the three scenarios. This is important because the elderly consume the biggest share of health resources; they are much more likely to be admitted to a hospital in an emergency and to have complex health problems.[94]

Figure 56: Home based health monitoring for patients in Scotland

A number of services across Scotland now offer home based health monitoring, particularly for people with chronic conditions such as pulmonary disease, heart failure and diabetes. The United4Health program is one such service - it gives patients a central role in the management of their condition. It does this through home-based monitoring of a patient's health and wellbeing.

Home based monitoring enables earlier detection of worsening health, supports self management and early treatment that helps avoid hospitalisation and/or early discharge from hospital for patients who can be monitored at home during recovery. It supports patients to digitally receive or capture information on their condition. If required, physiological and symptom information can be relayed from the home/community setting for clinical review and remote monitoring by health and care staff.

Source: Scottish Centre for Telehealth and Telecare

[92] Telemonitoring or structured telephone support programs for patients with chronic heart failure: systematic review and meta-analysis, BMJ (2007)
[93] Telemonitoring or structured telephone support programs for patients with chronic heart failure: systematic review and meta-analysis, BMJ (2007)
[94] Reshaping Care for Older People, Audit Scotland 2014

Finally, telemedicine can be useful in providing health care to people in hard to reach areas. In scenarios of greater digitalisation, more hospitals in rural and remote rural areas will also have access to this technology. This means that they can contact physicians in urban areas through telephone and video linkages while telemonitoring devices can keep regular track of patients' different physiological outcomes. This suggests that telemedicine can be used to overcome workforce shortage and the skewed distribution of specialists between urban and rural areas. For instance, in the Balearic Islands, telemedicine has been used in providing emergency stroke care to patients who previously had no access to it.[95] Scotland also has a national telestroke service which provides access to acute stroke treatment for areas that are unable to provide it 24/7 otherwise. Scotland's telestroke networks now cover 11 health boards but some are still not operational and many people in remote areas can still not be reached.[96]

4.1.3 Enhanced digitalisation and cost savings in the health sector

NHS Scotland had expenditure in excess of £11bn in the financial year 2013/14. This represented one-third of all Scottish Government expenditure in 2014.[97] As the population ages in the future, these costs are likely to increase. One of the advantages of eHealth is the potential cost savings it generates.

A number of studies have documented the cost saving impacts of eHealth. Sizeable national savings from eHealth were found in the US in two detailed studies conducted by the RAND Corporation and US Congressional Budget Office.[98,99] Similar findings have been made for other OECD countries and the United Kingdom in particular.[100] Two channels of savings enabled by enhanced digitalisation in the health sector are:

- Efficiencies enabled by telemedicine and telemonitoring.
- Efficiencies enabled by electronic patient management systems and their associated functionalities.

A selection of cost savings for Scotland across the three scenarios has been estimated for these two areas. The interventions have been selected based on the availability of data to estimate savings and on the priorities in Scotland's eHealth strategy. The selection of interventions covers the primary and secondary care sector; the former is the healthcare received from general practitioners (GPs) and walk-in centres while the latter is the care received in a hospital.[101]

Efficiencies enabled by telemedicine and telemonitoring

Telemedicine can replace in person appointments by telephone and video consultations and reduce waiting times during treatment. This reduces the cost of providing care. The cost savings from online pre-assessment in primary care, remote follow-up in secondary care and hospital admission reductions from telemedicine use in chronic disease treatment have been estimated for Scotland under the scenarios described in Section 2.

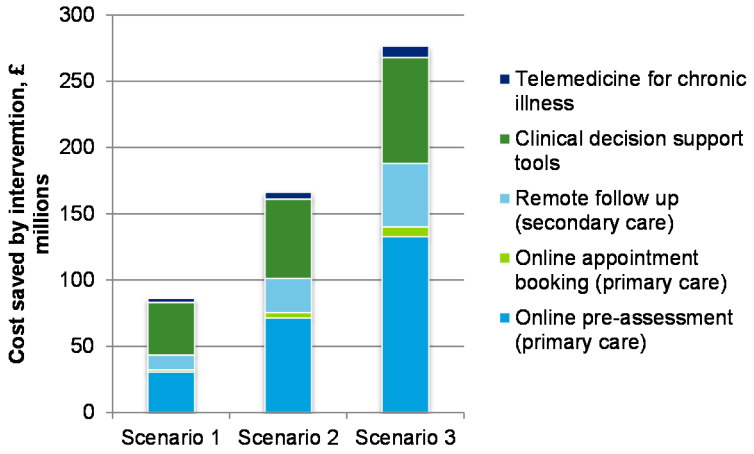
A report by the NHS identifies key eHealth interventions that can enable cost savings in the NHS. According to the report, telephone or online pre-assessment in primary care is an important way to reduce costs.[102] It estimates that approximately 31% of patients attending GP appointments do not actually need to attend. Surgeries can allocate clinician time more effectively by scheduling a telephone consultation with a senior clinician before booking a doctor's appointment. Primary care pre-assessment resulted in saving a GP up to five hours per week. It also resulted in an overall reduction in the time needed to help a patient, reduction in stress for clinical staff and improved patient experience.

Based on these findings, data on the number of primary care appointments and GPs in Scotland, and the current cost of GP's time, it is estimated that up to £130m could be saved by NHS Scotland by providing primary care pre-assessment to most of the population by 2030 (Scenario 3). The incremental cost saving from providing these services in Scenario 1 and 2 is around £30m and £70m respectively.

[95] Improving Health Sector Efficiency: the role of Information and Communication Technologies, OECD 2010
[96] http://www.sctt.scot.nhs.uk/archive/health/telestroke/
[97] Scottish Health Service Costs, Information Services Division Scotland
[98] Evidence on the costs and benefits of Health Information Technology, Congress of the United States Congressional Budget Office (2008)
[99] Extrapolating evidence of Health Information Technology savings and costs, RAND Health
[100] Improving health sector efficiency: the role of information and communication technologies, OECD (2010)
[101] http://www.west-middlesex-hospital.nhs.uk/about-us/freedom-of-information/publication-scheme/who-we-are-and-what-we-do/how-we-fit-into-the-nhs/
[102] Digital First: The delivery choice for England's population, NHS

It is assumed that in Scenario 1, less than half the physicians and hospitals have access to video consultation and telemonitoring services by 2030, in Scenario 2 around 65% have access and in Scenario 3 almost everyone has access to these services. This is compared to a counterfactual where around 30% of patients have access to these facilities.

Figure 57: Cost savings enabled by a selection of eHealth interventions in Scotland



Source: Deloitte analysis

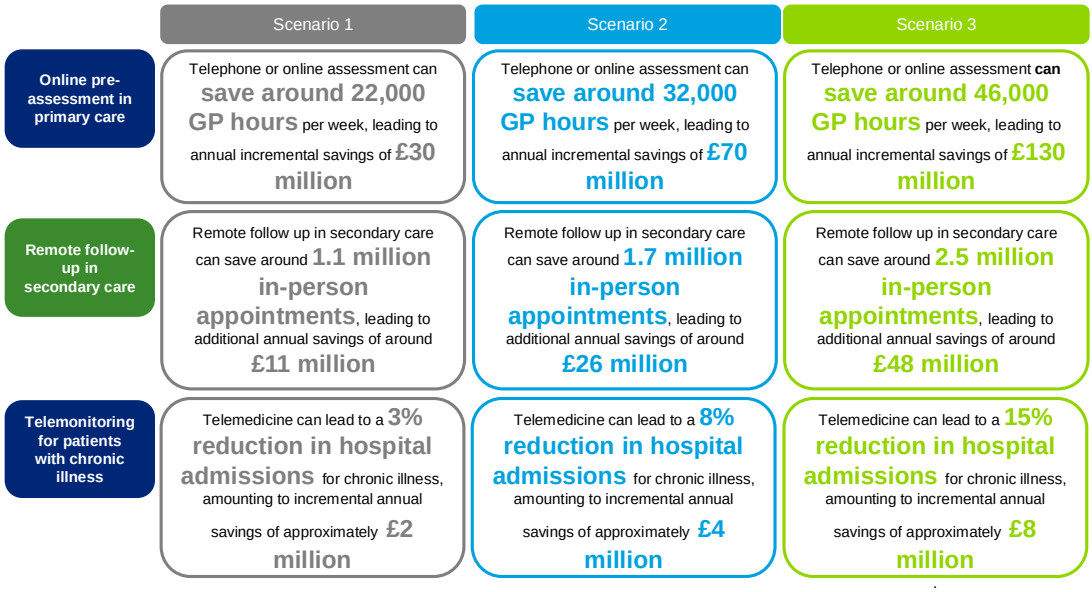
The same study also reports that many follow-up appointments in the secondary sector can also be reduced by telephone and video consultations. The results of a pilot project find a reduction in the number of hospital appointments and associated travel and time commitments for patients. This is estimated to generate savings of approximately £11m, £26m and £50m in Scenario 1, 2 and 3 respectively.

The impact of telemedicine on health outcomes of those with chronic illness was estimated in the previous section. It was found that telemedicine reduces the number of hospital admissions due to chronic illness. Using average hospital stay duration and bed cost data of the NHS, the monetary benefit of reduced hospital admissions was also estimated. This can be an incremental impact of up to £9m in Scenario 3.

The impacts estimated here are examples of the type and magnitude of savings enabled by telemedicine. The impacts from specific interventions can add up to accrue sizeable savings. For instance, one study on the socio-economic impact of mobile health in developed countries estimates that telehealth and remote monitoring could reduce overall health expenditure on the elderly by up to 25%.[103] This implies that in a scenario where almost all the elderly have access to telemedicine and telecare by 2030 (Scenario 3), potential savings of up to £1.4bn for the health sector in Scotland can potentially be achieved.[104,105]

[103] The socio-economic impact of mobile health, BCG
[104] This is 70% of the implied cost savings, to allow for gains already made
[105] According to Audit Scotland, total health and social care spending in Scotland on the elderly is £4.5 billion and it is expected to reach £8 billion by 2031.

Figure 58: Examples of cost savings enabled by different telemedicine interventions in Scotland

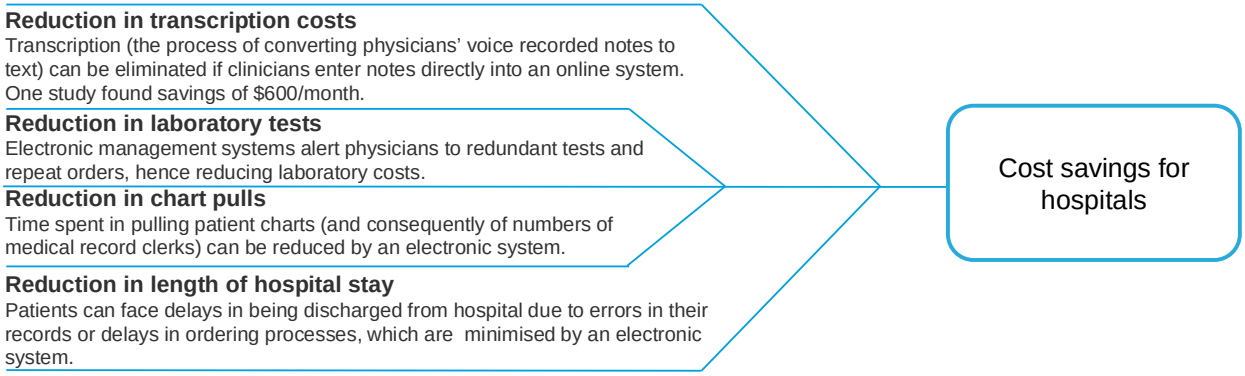


Source: Deloitte analysis

Efficiencies enabled by electronic patient management systems and their associated functionalities

By supporting physicians in prescribing the most cost effective medications and treatment plans as well as by saving time spent in synthesising patient information manually, patient management systems can improve efficiency in the NHS trusts.

Figure 59: Saving channels enabled by electronic management systems



Source: RAND Health

The cost saving impact of two features of patient management systems for Scotland have been considered: clinical decision support tools and online booking systems. Clinical decision support tools help to reduce laboratory costs by reducing the number of redundant tests (see Figure 59). A range of savings of between 11% and 22% of total laboratory costs has been observed.[106] Assuming increasing use of clinical decision tools across the scenarios, potential cost savings between £40m and £80m across the three scenarios for Scotland can be estimated (see Figure 60). [107]

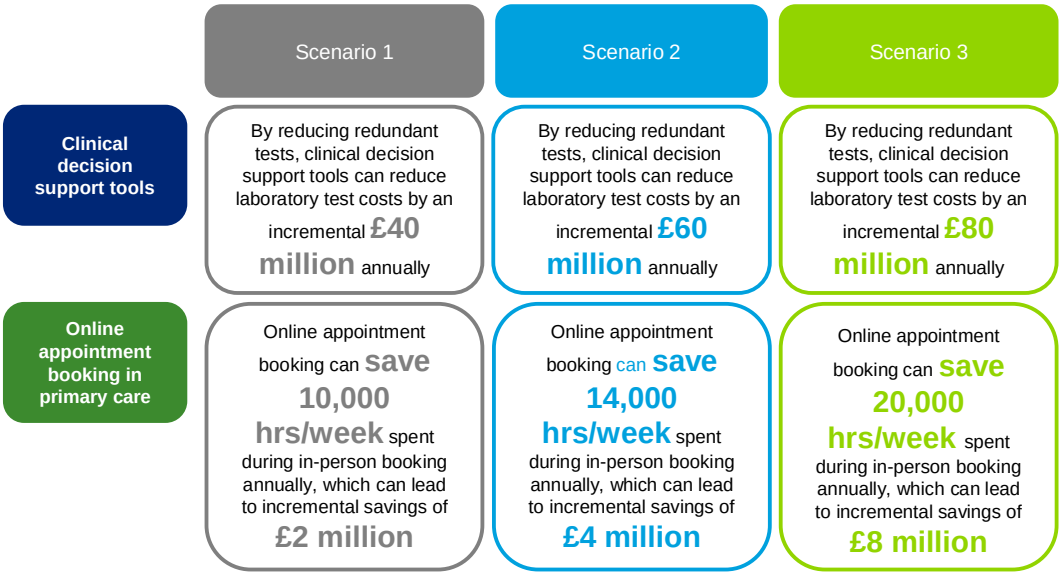
Computerised physician entries and clinical decision support features of electronic systems can potentially lower drug costs as well. They do so by structuring medication selection to align with formulary rules, advising physicians on the cost-benefit characteristics of specific drugs at the time of ordering, recommending cheaper alternative drugs such as generics and

[106] Extrapolating evidence of Health Information Technology savings and costs, RAND Health
[107] This is not the entirety of the cost saving enabled by clinical decision support tools; it is only the impact on test costs

encouraging providers to discontinue unneeded medication. This can result in up to a 15% reduction in drug utilisation in a scenario of enhanced digitalisation.[108]

Online appointment booking is a relatively easy to implement system that can also yield some efficiencies. Currently, around 25% of all NHS patients can book an appointment digitally.[109] Assuming that this facility is extended to just under half the patients in Scenario 1, around 65% in Scenario 2 and almost everyone in Scenario 3, incremental cost savings of £2m, £4m and £8m respectively could be generated.

Figure 60: Examples of cost savings enabled by some features of electronic systems



Source: Deloitte analysis

4.2 Impacts of enhanced digitalisation on education

Information and Communication Technology can contribute to extending universal access to education, equity in education, the delivery of quality learning and teaching, teachers' professional development and more efficient education management, governance and administration.[110]

Technology can potentially impact education delivery and outcomes in a number of ways – the internet and mobile devices can facilitate access to education resources. Information technology can improve the quality of curricula and education delivery and widespread adoption of technology can make education delivery more inclusive. These channels have the potential to affect education provision, from the primary, secondary and tertiary sector to continuing education and vocational training.[111]

Three channels through which information technology can impact education provision at school, college and university in Scotland are:

- It can enhance access to education resources;
- It can improve the quality of education resources and delivery; and
- It can enable greater equity in education access.

An OECD review of education in Scotland indicates that currently many outcomes, such as reading literacy and the gap between high and low achievers, are on par with other OECD countries. Scotland also has the first national intranet for school education called Glow, which is an online platform that all teachers and students in Scotland can access for learning materials. However, many schools and pupils do not actively use information technology as part of the curriculum. As Scotland moves

[108] A Cost-Benefit Analysis of Electronic Medical Records in Primary Care, The American Journal of Medicine, Wang et al (2003)
[109] The Commonwealth Fund 2010: International Health Policy survey
[110] http://www.unesco.org/new/en/unesco/themes/icts/
[111] http://en.wikipedia.org/wiki/Educational_technology

from a scenario of incremental digitalisation to one of more enhanced digitalisation, access to online learning materials would become more ubiquitous. This can improve equity in education access and quality.

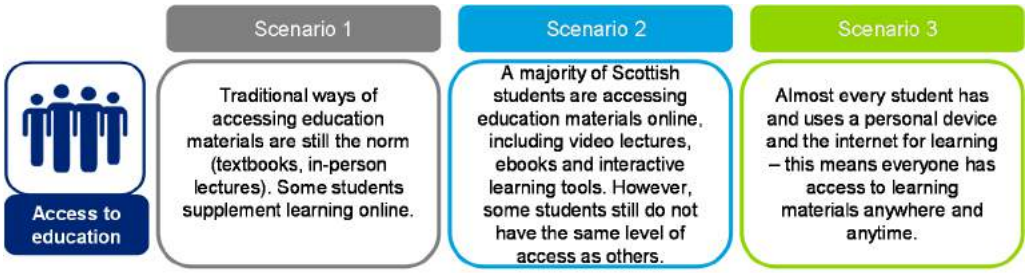
Whilst there are an increasing number of studies studying the impact of internet access and using digital technologies in schools, these studies primarily focus on small scale experiments that may be difficult to apply at a national level.[112] Studying the impact of digitalisation on education outcomes at a country level is an area that could benefit from more research.

Enhanced digitalisation and access to education resources

Enhanced digitalisation can make it easier to access education materials, such as lectures, texts, interactive learning tools and other audio-visual material. As the use of internet and devices increases across the three scenarios, more and more students also start to access learning materials online (see Figure 61).

In a scenario where Scotland is a world leader in ICT (Scenario 3) almost everyone will be engaging with the internet, meaning that anyone can access learning material online at any time. This facilitates the transition to an environment where learning is not only restricted to schools, but is happening continuously in other environments as well.

Figure 61: Impact of digitalisation on education access



Source: Deloitte analysis

One example of how improved internet and device penetration can enhance education access in Scotland is the national schools intranet, Glow. This is a Scotland-wide online platform where students and teachers can access a wide range of educational material. Glow can be accessed by any student at any time, which makes learning materials more accessible and their quality more equitable (see Figure 62).

Access to education resources is also linked to greater inclusion and equity in education, which is discussed in more detail below.

Figure 62: Glow - Scotland wide intranet for schools

Glow is a Scotland wide intra net for schools that has a wide variety of educational materials for students and teachers. It can be accessed from anywhere at any time – in school, at home or on the move, by anyone who has a password. Access to Glow is password protected; the Glow password is an important feature and automatically connects the user with appropriate materials and resources.

For educators Glow is a tool to access and develop high quality and relevant learning content, a space for collaboration and interaction with other educators, a way to access files and materials anywhere and anytime and a facility to build learning resources for pupils.

For learners it is a tool to access a range of online resources and services, a space for collaborating with other learners, a facility to connect with teachers and a space to create and innovate as one learns.

Source: Education Scotland

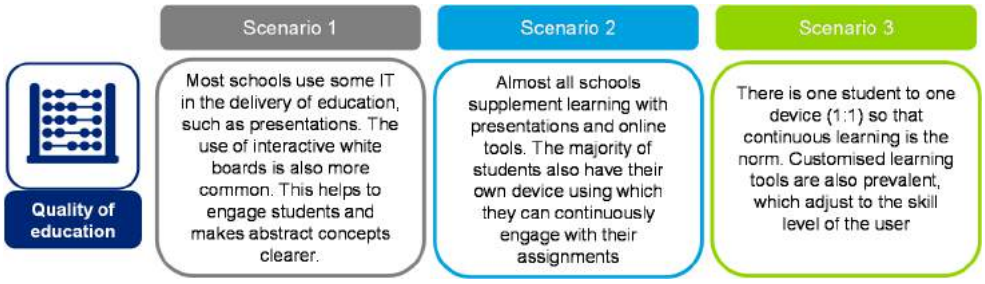
Enhanced digitalisation and the quality of education resources and delivery

Online resources such as videos, graphics and simulations can facilitate understanding and learning in the classroom.[113] The use of these resources becomes more widespread across the three scenarios. Less sophisticated technologies such as

[112] Higgins, Xiao and Katsipataki, 2012, The Impact of Digital Technology on Learning

presentation software and interactive white boards are common in Scenario 1 and accessible to all schools in Scenario 3. More sophisticated technologies, such as video conferencing and customised learning tools, become more common in the scenarios of enhanced digitalisation (see Figure 63).

Figure 63: Impact of digitalisation on education delivery



Source: Deloitte analysis

One example of a technology that is fairly prevalent in Scenario 1 and ubiquitous in Scenario 2 and Scenario 3 is an interactive white board, which is a large display that connects to a computer and is controlled by the user using a stylus. These have been the focus of a considerable number of studies; the results are almost universally positive, particularly where they are used in conjunction with other technologies and there are clear pedagogical reasons for their use.[114] Display and presentational software, including animations and simulations, combined with interactive white boards, help pupils to develop an understanding of abstract concepts through concrete examples and graphical images of, for example, microscopic processes.

In a scenario where Scotland is a world digital leader more advanced technologies, such as video conferencing, would also be used by many schools. The research indicates that a wide range of social and educational benefits can accrue from the use of video conferencing – benefits in curriculum learning, the development of social and communication skills and increased cultural awareness.[115]

A study commissioned by the Department for Education and Skills (DfES) on the impact of information technology in schools across the UK evaluates the video conferencing experience of 28 schools. The schools employed video conferencing for varying durations and principally for the subject areas of English, geography, history and modern foreign languages. It found video conferencing to be highly motivating to students, to enable links to be formed with other cultures, to support a shift to learner autonomy and to enable authentic learning experiences.[116]

Figure 64: Video conferencing in Scottish schools

A study involving pupils in a Scottish school conferencing with a school in the USA noted that attitudes to ethnic minorities became more inclusive and pupils developed a better understanding of their community environment and ethnicity issues.

Essentially, pupils interviewed individuals from ethnic minority groups living in Britain and subsequently edited the video footage for presentation to the American pupils. This involved consideration of what to leave in or to cut, reflecting on the issues that they wanted to raise and report during the video conference. While the pupils in this study recorded their own video, the findings also indicated that the judicious use of news footage could be used to develop critical thinking skills and improve perceptions of diversity.

Source: The impact of ICT in schools – a landscape review, Becta Research

Another important contribution of information technology in education is to provide innovative and customised models of learning that are a step change from traditional learning techniques. On a basic level, an example of this would be programs of one student to one computer or device (1:1) that have been implemented in some countries.[117] Each student has access to a device such as an iPad or smartphone 24/7 so that students are learning in and out of the classroom and are engaged with

[113] The impact of ICT in schools – a landscape review, Becta Research (2007)
[114] The impact of ICT in schools – a landscape review, Becta Research (2007)
[115] The impact of ICT in schools – a landscape review, Becta Research (2007)
[116] The impact of ICT in schools – a landscape review, Becta Research (2007)
[117] E-learning in the Republic of Korea, UNESCO

assignments and projects consistently. An iPad distribution pilot was also conducted in eight schools in Scotland, with a follow-up assessment showing positive results (see Figure 65). With enhanced digitalisation, such initiatives can be rolled out across more schools in Scotland.

Figure 65: iPad distribution in Scottish schools

A pilot project distributing iPads to eight individual educational locations was conducted in Scotland in 2012. Three models of 'personalisation' of the technology were found in the schools: some deployed sets of iPads for particular lessons, others used iPads across lessons but students were not allowed to take them home, while the third group of students was allowed to take the iPads home.

Follow up assessment of the pilot project noted key achievements. The main observations were:

- Many teachers noted that ubiquitous access to the internet and other knowledge tools associated with the iPad altered the dynamics of their classroom and enabled a wider range of learning activities to routinely occur than had been possible previously.
- The device also encouraged many teachers to explore alternative activities and forms of assessment for learning.
- Personal ownership of the device was seen as critical in increasing student motivation and promoting greater autonomy and responsibility for one's own learning.
- Over 80 per cent of parents considered the pilot project to have been valuable for their child despite its short duration and say it has significantly changed their child's enjoyment of and attitude towards school.
- Teachers noted that iPads had promoted more collaboration between them and students.

Source: iPad Scotland evaluation, University of Hull

A more sophisticated step change in pedagogy that could be brought about by highly enhanced digitalisation in Scenario 3 is the availability of learning software that adapts to a learner's skill level and needs. This can range from adjusting the level of difficulty of a test to best suit an individual student to delivering lesson plans in formats best understood by individual students. An elementary school in North Carolina is one example of a school that has successfully implemented such tools.[118] All the textbooks, notes, learning materials and assignments at the school are computerised, allowing teachers and parents to track a student's progress in real time. If a student is struggling, their computer-learning program can be adjusted to meet their needs and get them back up to speed. On the other hand, top students are constantly pushed to their limits by new curricular material on their laptops.

While the DfES assessment of ICT impacts in UK schools generally finds the impact of ICT on intermediate outcomes, such as motivation, engagement and independence in learning, to be positive, the impact on educational attainment is still under observation and more systematically gathered evidence is required to draw more conclusive generalisations.[119]

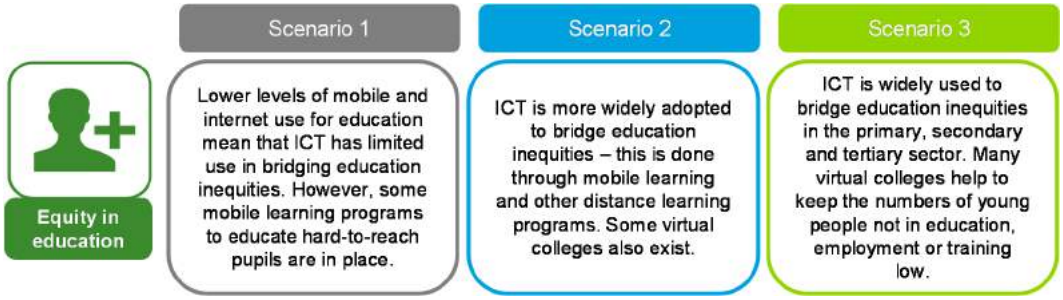
Enhanced digitalisation and equity in education access

An OECD review of the quality and equity of education in Scotland highlights some disparities in education access and outcomes in Scotland.[120] One of these is the link between deprivation and student attainment: over 40% of pupils living in the most deprived 5% of Scotland are in the lower attaining 20% group, compared with only 4% of the pupils living in the least deprived areas of Scotland. Another is differential access to schools in urban and rural areas: at primary school level 85% of pupils have a local authority school within three miles of their home but at secondary school level this drops to just over 40%, with much of the fall attributable to rural areas.

The use of digital technologies in education can be useful in addressing inequities in education provision. As more people in rural and remote rural areas access the internet and other devices in Scenarios 2 and 3, mobile technologies can increasingly be used to educate them. Research shows them to be effective in supporting learning for disaffected and 'hard to reach' pupils, where attending school is problematic for personal or family/cultural reasons.[121] The United Nations (UN) also works with many governments to use mobile technologies to provide education access to those who would otherwise not have access.[122] The same can be done for hard to reach pupils in Scotland.

[118] http://dailysignal.com/2012/08/20/back-to-school-the-rise-of-customized-education/
[119] The impact of ICT in schools – a landscape review, Becta Research (2007)
[120] OECD review of quality and equity in education outcomes in Scotland
[121] The impact of ICT in schools – a landscape review, Becta Research (2007)
[122] http://www.unesco.org/new/en/unesco/themes/icts/m4ed/

Figure 66: Impact of increased digitalisation on equity in education



Source: Deloitte analysis

More virtual colleges in Scenarios 2 and 3 can also help to keep more young people in employment or education. One area of concern for the Scottish Government is to reduce the number of young people that are Not in Education, Employment or Training (NEET) – currently around 12% of 16-19 year olds in Scotland are NEET.[123] There is evidence that disaffected students within the 14–19 age range can be supported through a 'virtual college'. In this setup each student has a tutor and both tutor and student have a laptop, email and fast internet connections. Much of the curriculum is delivered over the internet and students work towards a nationally accredited qualification. It was found that most pupils could eventually be reintroduced to the formal education system.[124] With increased digitalisation, information technology can be employed in this way to reduce the number of young people that are NEET in Scotland.

4.3 Impact of enhanced digitalisation on digital participation

Continual advances in technology mean that we now live in an increasingly knowledge-based society, with more of our interaction taking place in the digital world. Digital participation is the capacity of all groups in society to use and benefit from this increased digitalisation. In particular, it means that certain groups such as the elderly, those from more deprived socio-economic classes and those living in more remote areas all have the capacity and skills to fully engage with the internet.

From a policy perspective, it is about ensuring that nobody gets left behind and that everyone is able to exercise their right to engage with the community around them, access learning and services, and play a full role in society. That means making sure everyone has equal access to - and the skills to use - information and communication technologies such as computers and the internet, whether they want to access public services, use learning courses, or simply keep in touch by email with friends and family who are far away. Digital participation brings about social and economic gains, improving employability, access to public services and social cohesion (see Figure 67).

Figure 67: Impacts of enhanced digital participation

Source: Deloitte analysis

[123] OECD review of quality and equity in education outcomes in Scotland
[124] The impact of ICT in schools – a landscape review, Becta Research (2007)

4.3.1 Digital divide in Scotland today

There are a number of dimensions along which digital exclusion takes places in Scotland today, primarily age, socio-economic condition and geography.[125]

- The Scottish household survey shows that internet use among those aged 60 and above in Scotland is less than half of the population average use.[126] Low internet use among the elderly risks excluding them from being active participants in society.
- Area deprivation is associated with low levels of internet access – households in the least deprived communities are more than twice as likely to have internet access compared to those in the most deprived areas.
- Digital exclusion along geographical lines is more nuanced. The proportion of Scottish households with internet access does not differ significantly across urban and rural areas in Scotland but there is some evidence that households in rural areas are less likely to have broadband access compared to those in urban areas.[127] Download speeds are also generally lower in rural areas.

The Scottish Government has outlined several policies to improve digital participation and equality in general. The Digital Inclusion strategy 2007 builds on the 2001 strategy and outlines measures such as public internet access points and publicly funded resources to improve digital literacy. These policies have synergies with the public sectors' equality policies, which aim to achieve equality along age, gender and disability lines.[128]

4.3.2 Selection of impacts of enhanced digital participation

Extending internet and device access to the socially and digitally excluded can have a positive impact on a variety of different outcomes, including many of those in the Scottish Government's digital participation and equality strategies. In the context of the digital scenarios, as Scotland moves from scenarios of low digitalisation to more enhanced digitalisation, the digital divide across all the above mentioned dimensions decreases. In a scenario where Scotland is a world digital leader (such as Scenario 3), disparities in internet access by age, deprivation and level of rurality are almost non-existent, leading to a more productive and equitable society.

Improved employability

People with access to the internet are better positioned to search for a job and also have access to a lot more information on the labour market. While Scenario 1 still has a digital divide in internet usage, this narrows across the scenarios. This means that in scenarios of higher digitalisation people in rural areas who were not using the internet to search for employment earlier, will be able to do so now.

This is important for employability among these people because the internet has not only spawned a whole new range of jobs in the internet economy but it has also changed the dynamics of information exchange. Growth in access to the internet has played a major role in increasing the availability and exchange of labour market information. The internet plays an increasingly important role in information, advice and guidance services for people seeking careers, education, training and employment advice. This makes individuals utilising the internet better informed and more employable compared to those that do not.[129]

As illustration of how the unemployed can be engaged via the internet is the Public Internet Access Initiative implemented by the Scottish Government from 2002-2004. This created over 800 new public internet access points across Scotland, providing 100,000 users without home internet access with access in the community. Follow up assessment also showed it to be effective in attracting unemployed users to search for work, particularly in disadvantaged areas.[130]

[125] Digital inclusion in partnership, The Scottish Government
[126] Scottish household survey 2013
[127] Digital inclusion in partnership, The Scottish Government
[128] http://www.gov.scot/Topics/People/Equality
[129] Employment and the internet, Nominet Trust
[130] Digital inclusion in partnership, The Scottish Government

Greater social inclusion

As discussed above, currently the level of internet use among the elderly is much lower than the population average in Scotland. This is problematic as society is increasingly being organised around the internet and the knowledge society.

Reducing digital exclusion can help address many wider equality, social, health and wellbeing issues such as isolation**.** Of the people over 55, 81% say being online makes them feel part of modern society and less lonely.[131] Hence, as more and more older people use technology in scenarios of enhanced digitalisation, social cohesion and inclusion is likely to improve.

Reduced cost of living

According to a report by the UK Government, households that are offline are missing out on savings of £560 per year from shopping and paying bills online, or being able to keep in touch with family members and friends.[132] This means that people already in households with high deprivation face additional penalties for being digitally excluded. As more deprived households also start using the internet and acquire digital literacy across the scenarios, their cost of living would be expected to fall.

Part of these savings accrue because the internet allows households to access information about different goods and services and make price and quality comparisons. One example of how such benefits can materialise is the 'Digital Communities' initiative of the Scottish Government. This provided technology infrastructure and trainings to two disadvantaged communities and resulted in users engaging with the internet for a host of information (see Figure 68).

Figure 68: Digital Communities initiative in Scotland

In 2003, the Scottish government established two 'digital communities', one each in a disadvantaged urban and rural area. Within these areas about 3,500 homes received free personal computers (PCs) with free internet access for one year. In addition, a community-based web portal with locally developed content was established and an awareness campaign was started to make people aware of the benefits of being online.

A follow up evaluation of the initiative noted several changes in the use of and attitude towards computers and the internet. As expected, many more people started using these facilities once they were provided and educated about them. The most common tasks that were performed using the internet were accessing e-mail and finding information about goods and services. Following the intervention the mean confidence for performing various tasks on the computer increased for people across rural and urban areas, as did the proportion of respondents who said they would find it inconvenient to not have a computer anymore.

Source: Digital Communities Final Report, Scottish Executive

Increased civic participation

As government processes increasingly shift online, those that are digitally excluded can become less involved in civic and political life. This is especially relevant as public service provision, employment opportunities and processes such as voting start to be administered online. There is evidence to show that increased digital take up can improve participation in political and social life.

Studies from India and Mexico show that when people who did not have internet access before were provided access, most used the digital platform to read about citizenship and also took some action with regard to it. The most common actions were understanding their rights as a citizen (55%), understanding the country's legal system (37%), and registering to vote and participating in an election (29% and 36%, respectively).[133]

As an increasing number of people start engaging with the internet in scenarios of high digitalisation, it is likely that they also start to participate in civic and political life more actively.

[131] https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy
[132] https://www.gov.uk/government/publications/government-digital-inclusion-strategy/government-digital-inclusion-strategy
[133] http://oneglobaleconomy.org/wp-content/uploads/2015/01/Social-Impact-Evaluation-Report.pdf

Appendix A Digital connectivity: scenarios definition

A.1 Outcome-based scenarios provided by SFT

As a starting assumption of the study, SFT has provided a set of outcome-based scenarios for developments in Digital participation in Scotland. These are reported below[134] and SFT has noted that a report prepared by DCMS entitled "Digital Communications Infrastructure"[135] has been used to inform these scenarios.

Existing Position

The existing position is an attempt to capture the current level of digital connectivity and demand across Scotland. The world is fast moving and changes are happening daily: there are ever increasing moves to access new content and delivery methods for services, with some of these adopted by early up-takers, while others begin to become expected and 'standard' services. Alongside this, there are a number of infrastructure initiatives that seek to improve the fabric of Scotland's digital infrastructure and the impact of these programmes and projects will be felt in the near future, and will continue to do so going forward. There are, however, still great disparities in the accessibility, connectivity and quality of digital services across Scotland. This digital divide is driven by a number of factors and sees elements of Scotland's population being 'left behind' and unable to share in the benefits of the digital revolution. Consequently, Scotland's digital infrastructure will need to change to reflect the future requirements of its population, particularly as the levels of expectation on the availability, resilience and security of services grows exponentially.

Demand	Profile
General	In populated areas of the country, services and products exist which can deliver higher speeds and connectivity; however, elements and locations of society are excluded from the benefits of high speed access.
Bandwidth Use	Primarily audio-visual use.
Audio-Visual	Linear TV primary source of content. Set top box use: growing in terms of catch up TV services. DTT, satellite and cable strong offering.
Smartphones, Tablets, Mobiles, New Technology	Growing level of penetration, with increasing use, replacing more traditional forms of technology. 3G to 4G switch: 56.8% Scotland population coverage (outdoor).
Capacity	The private sector invests only where commercially viable to do so; consequently services are limited or non-existent in some parts of the country. For many populated areas, access to high speed and superfast broadband is available.

[134] Sourced directly from SFT
[135] DCMS, 2014, Digital Communications Infrastructure Strategy: Consultation document

Demand	Profile
Connectivity of Devices	As the growth of smartphones, tablets, etc. increases, the number of devices continues to grow. Whilst these use little bandwidth at present future demand will grow as other scenarios show.
Public Services	The prevalence and testing of online public services is evolving and starting to grow. Opportunities exist, however, there is generally a limited level of services online.
Online	64% of premises in Scotland are in areas where high speed broadband is available (speeds of at least 24Mbps). Broadband uptake (fixed and mobile) is 73% at a general level. In terms of mobile coverage, current indications suggest outdoor 2G coverage of 99.5% of the population, and outdoor 3G coverage of 97.3%. The market is stratified into two key sectors: residential and corporate. Corporate can secure faster, more resilient services, however, there is little in the way of bespoking for SME businesses, whose service levels are more akin to the residential sector.
Inclusion	There are still large sections of the population and locations of the country which have no or limited connectivity. The elderly, through lack of confidence or skills, have low levels of demand for access and services.

Scenario 1

Scenario 1 captures a general trend of growth, with greater penetration of demand and use of both services and technology increasing. Under the scenario the market is generally able to meet that demand, with new services and approaches beginning to evolve and grow. A number of households are still excluded from certain services and technology access.

Demand	Profile
General	Use risen further, however a number of users are not keeping pace with technology change and a number are still 'excluded'.
Bandwidth Use	Primarily audio-visual use.
Audio-Visual	Linear TV strong. Set top box use: limited to catch up TV services. 4K services (ultra HD TV) modest use. Internet Protocol TV modest use. DTT, satellite and cable remain strong.

Demand	Profile
Smartphones, Tablets, Mobiles, New Technology	Use has increased but rate of penetration has slowed. Steady switch from 3G to 4G: 95% population coverage in Scotland. Time spent per day not increased significantly: Common use of WiFi rather than the mobile network to connect. As move to 4G, services data consumption increases initially but then stabilises. 5G planned but not yet available.
Capacity	Increased volume requires greater capacity and traffic through internet exchanges increases, although there is greater availability of fibre services, whether at FTTC, FTTP or FTTH. Content service providers continue to invest in content delivery networks, with the caching of content moving increasingly into the network to meet consumer demand.
Connectivity of Devices	The Internet of Things will grow: by 2022 c.25-30m additional devices will be connected in Scotland. Majority of devices consume little bandwidth, although there will be a need for reliability for time sensitive communications.
Public Services	Use of online public services will continue to grow, with citizen transactions moving increasingly on line. Growth in e-health and online education applications and services.
Online	Users in densely populated areas will see continued improvements in level and capacity of services. Other areas see a minimum of 24mbps so that networks are likely to meet demand for consumers and small businesses. Corporate users able to obtain the greater speeds, bandwidth, resilience and security they require through known developing and existing products and competition. Mobile coverage has exceeded the coverage obligations on O2's 4G licence as the result of work by ESMCP and MIP projects: coverage 99% of the population and all major roads and railways. Other mobile networks will continue to match this coverage. Use of cloud based services grows.
Inclusion	Whilst improvement, there are still large numbers of the population and locations of the country which have limited connectivity (speeds between 2 and 24Mbps).

Scenario 2

Scenario 2 captures a scenario of increased demand and expectation around the types of services and applications available. Alongside this there is the expectation that services will be accessible wherever and whenever people want and the user experience will be good. This accessibility will be the key driver for people. There are also greater levels of inclusion, with the digital divide narrowing, as the simplicity of devices means a 'fear of technology' is removed for many alongside a greater level of digital competence amongst users.

Demand	Profile
General	Demand increases, as does the level expectation, over the services and applications available. Expectation services accessible wherever and whenever users demand. User experience is generally good.
Bandwidth Use	Audio-visual use remains the most popular type of content. Users expect to be able to access this content wherever they are, whilst enjoying a good user experience.
Audio-Visual	Linear TV remains strong. Increased, and complementary, use of catch up services and over the top (OTT) providers to view content when on the move.
Smartphones, Tablets, Mobiles, New Technology	Continued shift to smartphones and tablets, with the latter connected through WiFi rather than SIM card. Demand for wearable technology continues to evolve: seen as part of the luxuries consumer market rather as a core product. Use of these devices will be concentrated in areas of high density e.g. city centres. Wearable medical devices will become more widespread.
Capacity	The market will continue to build upon the vision of scenario 1, however, the market (both across the value chain and existing business models) may be resistant to change and may limit the ability or its willingness to respond to the demand needs outlined under scenario 2, leading to a slower take up of or adoption of services.
Connectivity of Devices	Users will expect multiple devices to connect together with ease and receive services across devices seamlessly. The market will resolve interoperability issues affecting connectivity between different devices. M2M communications will increase the number of connected devices, which significantly exceeds the number of people connected.
Public Services	Use of technology and services in cities will expand rapidly through Government interest and facilitation in driving smart cities. Concerns about the over reliance on technology will spill over into their use in health care and other areas.

Demand	Profile
Online	Home and remote working will have increased, but the majority of demand will still be related to the physical workplace. S&ME will increasingly engage in the digital world to meet the needs of their customers. They will require more symmetrical networks to allow greater uploading and sharing of files. Consequently a greater degree of security and resilience will be required by users. S&MEs will look for bespoke services rather than accessing services which will have been created for larger businesses or the individual consumer. Cloud based services will continue to grow steadily, but uncertainties as regards ownership of data will result in uneven progress.
Inclusion	The digital divide narrows as in terms of availability of high speed connectivity, but there may still be differing levels of confidence in being able to use services.

Scenario 3

Scenario 3 captures a scenario of met demand and future expectation, expectation that coverage and connectivity are implicit in that they are taken for granted, and that fixed and WiFi / wireless seamlessly work with each other. Devices are also simple to use and utilise whichever connectivity is available or best delivers the service required. This capability will drive convergence and bundling.

Demand	Profile
General	Users will expect coverage and connectivity wherever they are and whenever needed.
Bandwidth Use	Widely used for different services and needs. The norm will be symmetrical and high capacity broadband networks.
Audio-Visual	Continued demand for linear and non-linear television from across DTT and satellite, alongside a high degree of personalisation. High demand for IPTV and mobile viewing. Immersive and more effective transmission methods sought to further enhance the user experience. Move from 4K to 8K standards. Radio will increasingly be delivered by streaming to connected devices.
Smartphones, Tablet, Mobile, New Technology	Content will be stored on the internet closer to users to meet the need for instant access to such services. Each home will be a home network with equipment readily available, easy to use and affordable and equipment will automatically connect to each new device.

Demand	Profile
Capacity	A significant increase in demand will require superfast speeds of over 1Gbps applying to both uplink and downlink. This fuelled by ongoing changes in user experience, new devices, technology and content. Resilience for all will be expected, delivered by having both fixed and mobile networks covering the country, with availability or capacity, reliability, low latent and noise levels. This group of service metrics will replace the current emphasis on speeds and regularly updated. Networks will be scalable and able to respond more rapidly to demand through virtual network management. SMEs require these metrics, together with greater transparency around quality of service and enforceable SLAs. Service differences in service provision across geographies will not be tolerated.
Connectivity of Devices	Deployment of connected devices will exceed expectations, driven by smart homes, smart cities, smart energy, e-Health and the growth in the intelligence of machines.
Public Services	Use of technology and services will expand rapidly across the country (outwith cities and populated areas) through continued Government interest and facilitation. There will be no distinction between densely populated and isolated communities in terms of services accessible and available.
Online	Demand will be user specific and not location specific. The distinction between individuals and small businesses will become blurred and with increased home and remote working, demand will drive better quality of service across all networks. The corporate market will continue as a distinct market. Improvement in performance networks will drive an ongoing expectation for even better networks. The majority of businesses will fully embrace working digitally as competitive forces make this essential. This will create further demand across the country. Voice traffic will shift predominantly to mobile and this with the Internet of Things will drive network expansion. Fixed lines will only be retained for broadband connectivity with copper being phased out. Cloud technology will be the norm.
Inclusion	Broadband pricing will be relatively affordable given their interdependence with WiFi and mobile operators will price to encourage high data usage. Building upon the changes also identified in Scenario 2, the digital divide is almost eliminated.

World Class 2020[136]

World Class 2020 encapsulates the range of services, applications and devices available and the connectivity which enables anything, anywhere, anytime. These include:

[136] http://www.gov.scot/Publications/2013/02/9054/2

- 95% of the population under 75 is online, while everyone who wants, needs or can be online is able to do so. Everyone is digitally confident.
- The default method of public service delivery is online.
- Significant digital clusters in the seven cities (digital cluster - cities are key sites for economic growth for themselves and their hinterlands; in the digital economy they provide for the hybrid bricks and mortar business with a digital portal – they drive digital innovation and help keep it grounded in tradition)
- Mobile connectivity: 98% of geography and >99% of population
- Progressive fibre rollout to all settlements > 1,000 premises
- Commercial packages offering connectivity 250Mbps – 1 Gbps
- 98% of SMEs using cloud-based services, visible impact of ubiquitous computing and intelligent sensors
- The default engagement with healthcare is online – from booking to remote support. All citizens use a wide range of e-health services - body area networks (wearable computing devices)
- Teachers and students of all ages utilise the new forms of e-learning, learning new skills and expanding their contribution to the workforce

A.2 Scenario quantification

On the basis of the guidelines and indications provided by the outcome-based scenarios above, four scenarios have been estimated in detail. For each scenario, an estimation has been undertaken of the following variables:

- Audio-visual: This is a key driver of usage due to the proportion of bandwidth consumed by audio-visual. As consumers move to higher definition audio-visual services this acts to increase the amount of data consumed per hour of audio-visual. This includes both long form audio-visual, such as films and TV programmes, and short form audio-visual, such as YouTube videos and news clips.

- Consumer: Whilst viewing websites does not consume much data compared to uses such as audio-visual, accessing information online and online shopping is an important driver of internet usage.

- Business use: Businesses are increasingly digitalising their operations, such as the use of cloud computing. This increases the ability of employees to work remotely and enables more firms to conduct some amount of business through the internet.

- Public sector: Digitalisation of public sector administration and communications increases the amount of data used. Offering more e-government services online contributes to the penetration levels and the use of devices in public services such as health and education further contribute to higher usage levels.

- IoT: As digitalisation increases in the economy, the number of connected devices increases. These can be used for consumer, business and public service provision. Whilst there may be many devices, potentially outnumbering the number of smartphones, the usage per device is comparatively low.

It is noted that these scenarios are not intended to be a forecast of penetration and usage in Scotland, but rather as an estimation of what penetration and usage profiles could materialise to achieve the digital outcomes indicated by SFT.

Details on the metrics for each scenario are reported below.

Scenario 3: “Scotland as an ICT world leader”

Scenario guidelines

- Anytime/anywhere connectivity with seamless transitions between fixed and wireless networks, and multi-purpose devices are the norm.
- Highest digital demand characterised by very high levels of usage with the digital divide effectively eliminated.
- The internet is used universally for a range of services. The majority of bandwidth use is audio-visual due to the successful move from 4K to 8K audio-visual standards, with high demand for IPTV and mobile viewing.
- Connected devices are commonly and widely used in the home, for business, across towns and for public services.
- The use of technology and enabled services shows no differences in provision by geographical area, and cloud services are common across activities.

Implications for digital services

Audio-visual usage

- A high proportion of media and communications time is spent watching TV/films on non-TV devices such as mobile viewing, which is assumed to reach over 9% by the end of the period.
- In addition, there is high demand for IPTV. The increased demand for internet delivered audio-visual combines with an increased demand for higher definition audio-visual.
- This may mean that by 2025, almost half the connected population are watching Ultra HD TV and by 2030 the large majority, 80%, are watching Ultra HD TV. By the end of the period the migration to 8K TV has begun with 10% of people now viewing 8K audio-visual.
- The high resolution viewing, especially in later years, leads audio-visual data usage to rise to 190GB per fixed connection per month and 75 GB per connection per month, accounting for three quarters of all data usage.
- This is equivalent to 11 Ultra HD films per month over a fixed network and 4.5 Ultra HD films on a mobile device.

Consumer usage

- Nearly everyone is using the internet for shopping and accessing financial services through online banking. The internet is the most regular place that people go to find out about news and find information.

Business usage

- Nearly all businesses have a NGA broadband subscription; it is assumed that 98% of large businesses and 95% of SOHOs use NGA broadband, up from 48% and 17% respectively in 2014.
- The large majority of firms are using digitally enabled software, including cloud computing and management software to improve activities such as supply chain management. Nearly all firms, 99%, have a website representing a significant increase in digitalisation for micro firms, as only 70% had a website in 2014. The increase in digitalisation has enabled B2B e-commerce and B2C e-commerce to increase over the period, with three-quarters of these firms making some sales over the internet compared to 50% in 2014.
- There has also been an increase in the number of firms allowing employees to work remotely. The increased proliferation of these technologies compared to the other scenarios has resulted in an increase in NGA broadband penetration and usage by businesses. Mobile is still used by businesses as workers as employees use tablets to work on the move.

Public sector usage

Increased online provision of public services is a key driver of world leading connectivity as people access public services online as the norm. The public sector components have been informed by a review of international benchmarks with current world leaders, such as South Korea and Denmark, and expectations of new technologies.

- **E-government**: The central government and local councils have fully digitalised administration systems. All government departments use the same system to allow interoperability.
    - This allows for activities such as fiscal management to be conducted on the same system for all government departments. Furthermore, the fiscal management system allows for real-time management and analysis to be undertaken.
    - Cloud computing is also used by all departments. Using cloud computing allows for the integration of individual data centres and systems. Integrating this information also facilitates data sharing across the public sector.
    - The government also offers a large range of online public services at both the local and central government levels. It is assumed that 90% of people and businesses use these services at least once a month by 2030, up from 60% currently.
    - The range of services includes an online citizen portal, allowing people to find information and download forms, an online procurement system, tax system, customs clearance system, and an online immigration control system.
    - Local councils will also be providing information and services, such as reporting issues, and applying for services and tax changes. There is a move towards mobile government, which will allow citizens to use services such as real time intelligent public safety services.
- **E-health**: Near 100% digitalisation of messages is assumed by the end of the period among healthcare professionals, making NHS Scotland almost entirely paperless.
    - The day to day record keeping and management of health activities is conducted via an online portal which allows both practitioners and patients to access the health records. Community workers/local doctors are able to transmit high resolution images, such as CT scans, to hospitals and specialists without the patient needing to travel long distances.

- All elderly people requiring non-hospital care are cared for using telecare and telemedicine devices, such as devices to detect lack of activity, falls and manage medication. Sophisticated telemonitoring devices are used to report on patient's diagnostic information. These devices allow for real time monitoring of a patient's health and can provide advance warning of a potential issue. For example, a device can be used to send regular updates on a patient's cholesterol.
- As a result, Scotland develops an international reputation as a centre for the research, development, prototyping and delivering of innovative telehealth and telecare services and products at scale.

➢ **E-education**: Digital technologies are used to improve the quality of primary and secondary education as well as improve accessibility to tertiary education.

- In primary and secondary education, ICT is incorporated into the content and delivery of education materials, in teacher training, evaluation, monitoring and administration of the education system.
- Nearly all students have a device such as a tablet or laptop which allows teachers to offer customised learning tools and feedback to each individual student and helps teachers to track a student's progress.
- Students also use a large number of programmes and applications that teach, evaluate performance and provide feedback. The increased level of information over a student's progress helps parents to become more informed about their child's progress.
- In the tertiary sector, there are many virtual and traditional universities that offer online courses. This allows people to complete courses, professional qualifications and degrees online. Enabling distant learning will make it easier for people to study part time courses at institutions other than their local one, thus improving the average quality of education. Online courses will also be accessible to people outside the country, thus increasing the potential for extra exports from the education sector in Scotland.

Internet of Things

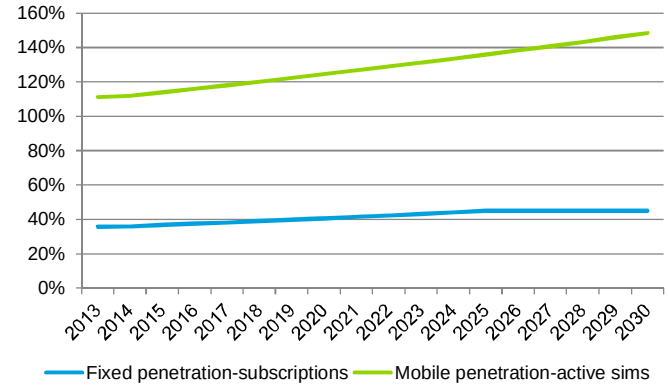
- Using the high demand scenario forecasted by Ofcom[137] to inform the development of connected devices, there are approximately 130 million connected devices in Scotland. The use of IoT devices is widespread by large business, SMEs and consumers. All these groups are increasingly using the devices; using Cisco forecasts to inform usage per connection results in increased data usage from 0.06GB per connection per month to 0.29GB per connection per month by 2020.[138]
- This includes nearly all cars being connected, smart meters in homes, monitoring devices in many machines and consumer products. There are enough devices per person/household to allow the connected devices to communicate with each other and make decisions.
- The public sector is also making use of IoT technology through Smart Cities and in the provision of public services, such as every communal bin having a sensor in to detect how full it is. This information can be used to optimise the public services whilst reducing costs, and improve the general environment through reduced littering.

Penetration

- Both fixed and mobile penetrations are defined as the number of subscriptions per 100 people. Penetration will increase so that nearly all people have access to the internet.
- For mobile penetration, this scenario assumes a penetration of unique subscribers of 99%, while the number of households with fixed broadband is 98%. Fixed penetration is assumed to reach this level by 2025.
- There is almost no digital divide in terms of access to the internet.
- Penetration and usage in urban and rural areas is very similar.

[137] A report for Ofcom by Aegis spectrum engineering and Machina Reseach, 2014, M2M application characteristics and their implications for spectrum.
[138] http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country

Figure 69: Fixed and mobile penetration

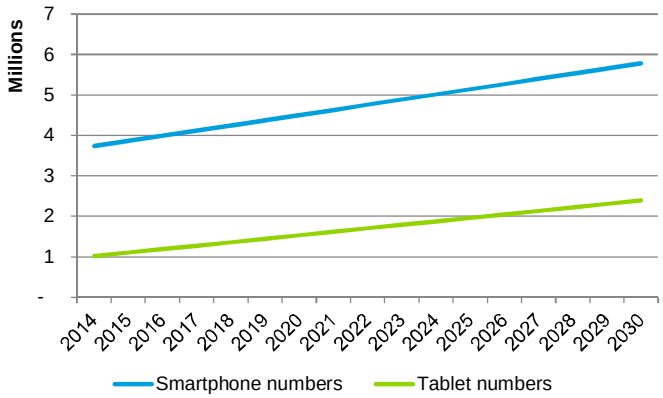


Source: Deloitte analysis

Devices

- Smartphones fully replace feature phones. Smartphone penetration reaches slightly over 100%. The number of tablets increases until approximately half the population owns one.
- There are approximately 1.5 smartphone/tablet connections per connected person by the end of the period. The number of smartphones in the economy helps to enable the increases in mobile usage per connection.

Figure 70: Number of smartphones and tablets

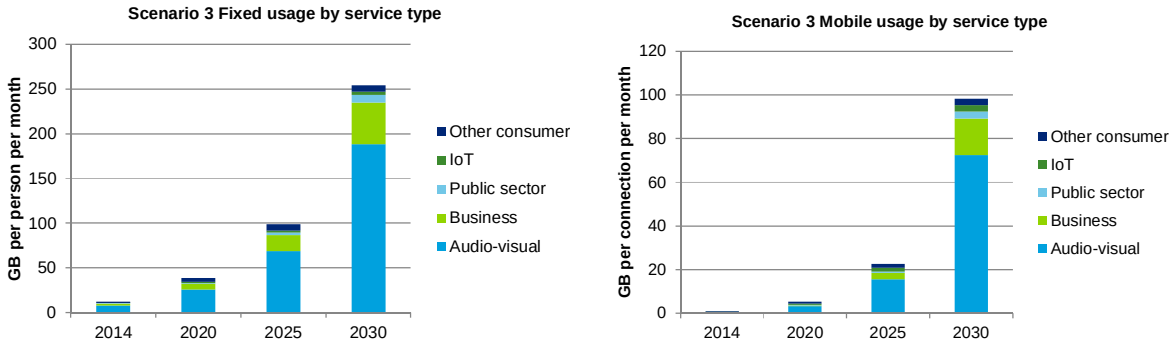


Source: Deloitte analysis

Usage profiles

- Based on the service take up discussed above, the usage profile per connection is characterised by quickly growing usage driven by more time spent watching higher definition audio-visual services and increasing digitalisation amongst businesses, public sector and the IoT.
- By the end of the period fixed usage is 20 times larger than it is today and mobile is over 100 times larger.

Figure 71: Fixed and mobile data usage per connected person



Source: Deloitte analysis

Scenario 2: “Building on Scotland’s world class ICT 2020”

Scenario guidelines

- Users expect to be able to access services wherever and whenever they demand it, and multi-purpose devices are common.
- Demand for digital services is characterised by high levels of usage. The digital divide has narrowed in terms of access to high speed connectivity. The digital divide is now defined by the level of confidence in using and relying on technology.
- The primary use of bandwidth is for the consumption of audio-visual services with consumers accessing content wherever they are resulting in relatively high demand for IPTV and mobile viewing.
- The number of connected devices significantly exceeds the number of people. Device growth is driven by large business and public services with smaller businesses and consumers using a few applications.
- The use of technology by businesses and technology will increase although there will be some resistance to adoption in some areas due to a worry of over reliance on technology. This will slow the rate of adoption in some areas such as cloud computing for smaller firms and in the provision of E-health.

Implications for digital services

Audio-visual

- An increasing proportion of media and communications time is spent watching TV/films on non-TV devices such as mobile viewing, which is assumed to reach over 7.5% by the end of the period.
- There is also a relatively high demand for IPTV. The increased demand for internet delivered audio-visual is combined with an increased demand for higher definition audio-visual.
- By 2025, 30% of the connected population are assumed to watch Ultra HD TV and by 2030 the large majority, 70%, are watching Ultra HD TV. By the end of the period, early adopters have begun to use 8K audio-visual with 5% of people now viewing 8K audio-visual. However, a quarter of people are still watching HD video.
- The high resolution viewing especially in later years leads to audio-visual data usage to rise to 130GB per fixed connection per month and 60 GB per connection per month, accounting for almost three quarters of all data usage. This is equivalent to eight Ultra HD films per month over a fixed connection and four Ultra HD films over a mobile network.

Consumer usage

- The use of the internet for shopping, banking and accessing news has increased significantly so that now over 85% are making some use of these services via the internet.

Business

- The majority of businesses have an NGA subscription; 96% of large businesses and 75% of SOHOs are assumed to use NGA broadband, up from 48% and 17% respectively.
- Nearly all large firms are using digitally enabled software, including cloud computing and management software to improve activities such as supply chain management. Whilst many SMEs and SOHOs are using cloud computing for data storage, a large number of the smaller firms are making little use of management software. Whilst 99% of all medium and large businesses have a website, enabling an increase in online sales, 10% of SOHOs are assumed not to have a website. In general, digital technologies play a larger role in large companies than smaller ones still.
- The increase in digitalisation is assumed to have enabled B2B e-commerce and B2C e-commerce to increase over the period with two-thirds of firms making some sales over the internet compared to 50% in 2014.
- The lower penetration of NGA broadband and lower usage of digital technologies causes business usage to be lower than in the world leader scenario.

Public sector

Online provision of public services has become commonplace. This contributes to improved penetration as people make use of easier access to public services. The public sector components have been informed by international benchmarks with current world class countries and expectations of new technologies.

- **E-government**: The central government and local councils have near fully digitalised administration systems.
  - Whilst progress is being made to interoperability, there are still a few different systems used across the public sector.
  - Cloud computing is also used by all departments, although the few different systems in place reduce the potential for data sharing across the public sector.
  - The government also offers a relatively large range of online public services at both the local and also some at the central government levels. It is assumed that 80% of people and businesses use these services at least once a month, up from 60% currently.

- The range of services includes an online citizen portal, allowing people to find information and download forms, an online procurement system, tax system and e-customs. Additionally, local councils will also be providing information and some services, such as applying for services and tax changes.

- **E-health**: There is near 85% digitalisation of messages among healthcare professionals, making NHS Scotland almost entirely paperless.
  - The day to day record keeping and management of health activities is primarily conducted via an online portal which only allows practitioners to access the health records. Community workers/local doctors are able to transmit high resolution images, such as CT scans, to hospitals and specialists without the patient needing to travel long distances. However, community workers are not fully paperless and still have to send some information to be scanned into the online portal.
  - The use of telecare and telemedicine to look after people in their homes is advanced. However, advanced equipment in some niche telemedicine areas, such as pre-natal medicine, is not fully up to date. Telemonitoring devices are used in some areas. However, there is a geographical divide in the use of these devices with some NHS trusts being wary of over relying on technology as well as some resistance from people in the local area.
- **E-education**: Digital technologies are used to improve the quality of primary and secondary education as well as improve accessibility to tertiary education. However there is an implementation gap resulting in a geographical divide in e-education.
  - Basic provision of computers, laptops and high speed internet is in place for most schools. Many schools also use self-directed learning programs to customize the learning of students and allow parents and teachers to monitor their progress effectively.
  - The use of ICT in learning has been integrated into the overall curriculum by having a coordinated approach to e-education by the government – the government ensures that there is a uniform curriculum that incorporates the use of ICT and trains teachers to use ICT tools effectively in the classroom. Although the digital divide is narrower than in scenario 1, some gaps in access to e-education tools between urban and rural areas remain.
  - In the tertiary sector, more virtual universities have sprung up and there is a culture of online education. Almost all universities offer an online course on their programme. Online education is actively being used to improve education outcomes in rural areas and in corporate training programs. Portals that connect universities with each other and allow them to share resources are common.

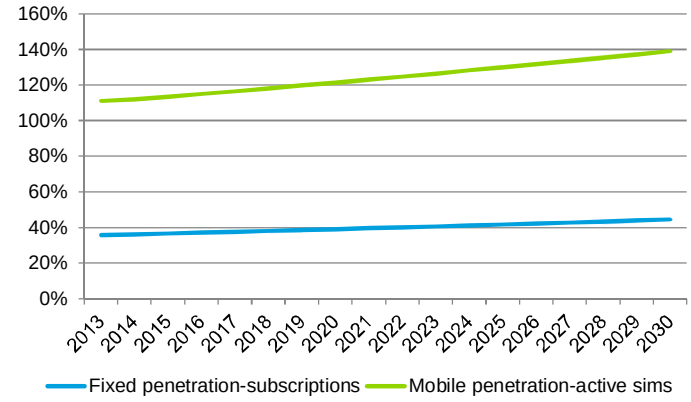
Internet of Things

- Using the medium-high demand scenario forecasted by Ofcom to inform the development of connected devices, there are over 90 million connected devices in Scotland. The use of IoT devices is widespread by large business with SMEs and consumers using a few applications of the technology. The usage of these devices is increasing as people learn how to best use them and make the most of having devices connected to each other.
- This includes the majority of all cars being connected, smart meters in homes, as well as monitoring devices in many machines and consumer products. There are enough devices per person/household to allow the connected devices to communicate with each other, however the number of applications desired by consumers is not as high as in scenario 3 and many products produced by SMEs are not connected.
- The public sector is also making use of IoT technology through Smart Cities and in the provision of public services. However, the use is restricted by concerns about being over reliant on technology.

Penetration

- Both fixed and mobile unique subscriber penetration will increase so that approximately 97% of people have access to the internet by the end of the period. The digital divide still exists in terms of usage.

Figure 72: Fixed and mobile penetration

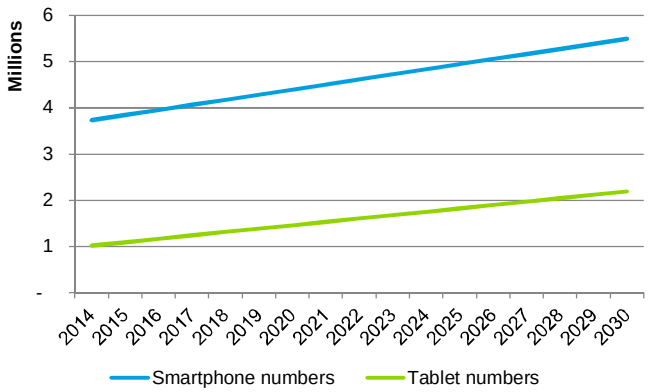


Source: Deloitte analysis

Devices

- By the end of the period smartphones almost fully replace feature phones with smartphone penetration reaching slightly over 95%. The number of tablets increases until approximately 40% of the population owns one. There are approximately 1.4 connected devices per connection.

Figure 73: Number of smartphones and tablets

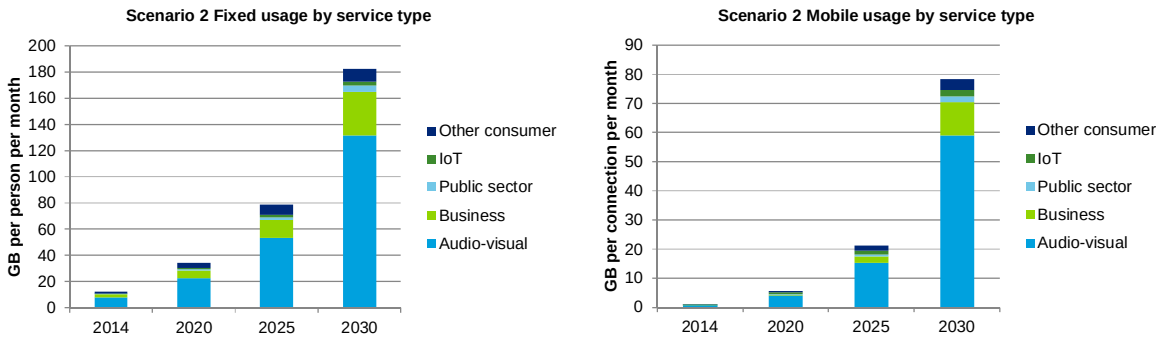


Source: Deloitte analysis

Usage (GB per connection per month)

- The usage profile per connection is characterised by growing usage driven by more time spent watching internet delivered higher definition audio-visual services and increasing digitalisation amongst businesses, public sector and the IoT.
- However, the increase in the usage is not as large as in the world leader scenario. Fixed usage by the end of the period is 15 times higher than 2014 and mobile usage is 80 times higher.

Figure 74: Fixed and mobile data usage



Source: Deloitte analysis

Scenario 1: “Incremental improvement”

Scenario guidelines

- The market is generally able to meet demand, with new services and approaches beginning to grow.
- Demand for digital services is slightly above trend and is characterised by moderate levels of usage. The digital divide is still present across consumer groups and geographical areas.
- The primary use of bandwidth is for the consumption of audio-visual services. However demand for Ultra HD TV, IPTV and mobile viewing remains relatively modest.
- Connected devices will be used relatively sparingly in the home, for business, across towns and for public services with approximately 30 million devices.
- The use of technology, such as cloud technology, is growing but the adoption is slower and is fastest for larger businesses.

Implications for digital services

Audio-visual

- An increasing proportion of media and communications time is spent watching TV/films on non-TV devices, which is assumed to reach 6% by the end of the period. The slightly higher demand for internet delivered audio-visual is combined with a slightly higher demand for higher definition audio-visual compared to the counterfactual.
- By 2025, 15% of the connected population are assumed to be watching Ultra HD TV and by 2030 the large majority, 60%, are watching Ultra HD TV. However, by the end of the period 40% of people are also watching HD audio-visual and 8K standards have not been adopted.
- The higher resolution viewing especially in later years causes audio-visual data usage to rise to 70GB per fixed connection per month and 30 GB per connection per month, accounting for two-thirds of all data usage.

Consumer usage

- The use of the internet to research and access goods and services has become slightly more common in society although the majority of the elderly are still not using the internet for shopping, banking and news access.

Business

- It is assumed that by the end of the period the majority of businesses do not have an NGA subscription; 92% of large businesses and 43% of SOHOs use NGA broadband, up from 48% and 17% respectively. This assumption is informed by the 2014 Digital Business survey.
- Many large firms are using digitally enabled software, including cloud computing and management software to improve activities such as supply chain management.
- Whilst it is assumed that the small majority of SMEs and SOHOs are using cloud computing for data storage, a large number of the smaller firms are assumed to be making little use of management software. Whilst 99% of all medium and large businesses have a website, enabling an increase in online sales, it is assumed 20% of SOHOs still do not have a website. In general digital technologies play a larger role in large companies than smaller ones still.
- The increase in digitalisation has enabled B2B e-commerce and B2C e-commerce to increase over the period with 60% of firms making some sales over the internet compared to 50% in 2014.

Public sector

Increased online provision of public services contributes to improved penetration as people make use of easier access to public services.

- **E-government**: The central government and local councils have taken steps to improve the level of digitalisation of their administration but there is still work to be done and most use their own systems which reduces the potential for interoperability.
    - Cloud computing is used by many departments, but the different systems reduce the amount of data sharing that is possible.
    - The government also offers a relatively large range of online public services at both the local and also some at the central government levels. It is assumed that 70% of people and businesses use these services at least once a month, up from 60% currently.
    - The range of services is relatively limited and includes an online citizen portal, allowing people to find information and download forms, and an online procurement system. Additionally, local councils will also be providing information and some services, such as applying for services and tax changes.

- **E-health**: It is assumed 60% digitalisation of messages among healthcare professionals, making the majority of NHS Scotland paperless.
    - The day to day record keeping and management of health activities is primarily conducted via an online portal which only allows practitioners to access the health records. The transition to electronic health records is almost complete except for remote rural regions.
    - Telecare and telemedicine is also commonly practised but the best international practices and standards have not been achieved. There is room to better use telecare tools to narrow the digital divide in healthcare services and to care for the aging population. The use of telemonitoring devices remains rare due to the lack of demand for these devices.
- **E-education**: In terms of ICT infrastructure, most schools in urban areas have access to computers and high speed internet. However, many schools in rural and remote rural areas do not have these facilities or have them at a very basic level.
    - The national intranet for schools, Glow, has expanded to include teaching materials on more subjects and more tools for content creation for teachers. Its use has become better integrated into education at the primary and secondary school level by training teachers to effectively incorporate it into the curriculum.
    - Many students use personal tablets and other internet enabled devices to learn, but their impact is limited in a number of ways. Firstly, they are not fully integrated into the curriculum but are mostly used to supplement the main learning in the classroom. This means that the benefits of customised teaching plans and self-directed learning are not being reaped fully. Secondly, access to more sophisticated learning programs and devices is limited to the top schools, so that the digital divide in ICT usage persists.
    - In the tertiary sector, the provision of online education has increased. Currently, most Scottish universities are connected via Janet, a private, UK government-funded organization, which provides computer network and related collaborative services to UK research and education. Under this scenario, this collaboration has increased to offer joint online courses and to share teaching material. Distance and online learning programs are more common and a large number of people take them. However, there is still no proper accreditation of online courses and degrees, which remains a major hindrance in their uptake.

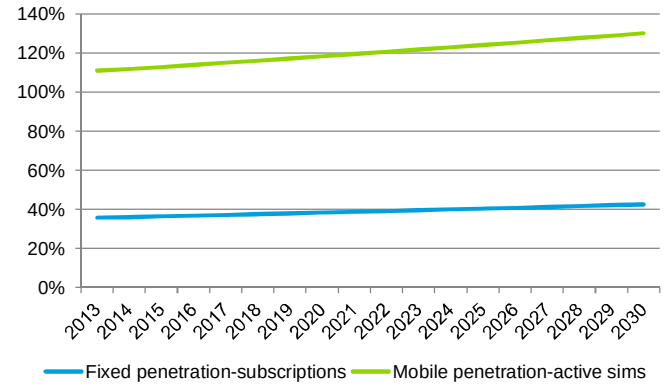
Internet of Things

- Using the low demand scenario forecasted by Ofcom to inform the development of connected devices, there are approximately 30 million connected devices in Scotland. IoT devices are used by large businesses for a few applications and are rarely used by SMEs. The use by consumers is primarily limited to smart meters and in cars.
- The minority of people own enough devices to experience the benefits from connected devices communicating with each other.
- The public sector is making limited use of IoT technology. The applications are primarily limited to the provision of e-health and public transport.

Penetration

- Unique subscriber penetration will increase so that approximately 93% of people have access to the internet.

Figure 75: Fixed and mobile penetration



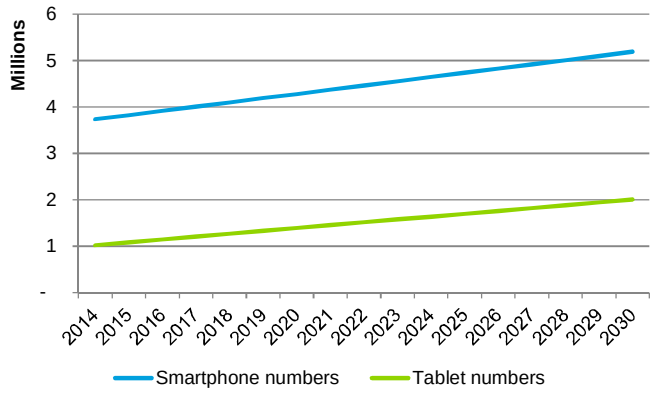
Source: Deloitte analysis

Devices

- The number of smartphones increases as people replace feature phones. However, there are still some feature phones used by people as smartphone penetration only reaches slightly over 95%.

- The number of tablets increases until approximately 35% of the population owns one. By the end of the period the average number of devices is 1.3 per connected person.

Figure 76: Number of smartphones and tablets

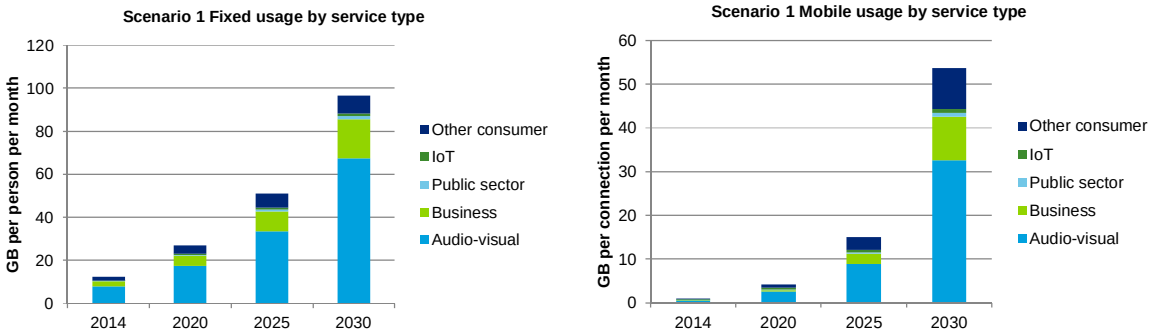


Source: Deloitte analysis

Usage (GB per connection per month)

- The usage profile per connection is characterised by comparatively slow growth in usage driven by spending slightly more time spent watching higher definition audio-visual services and gradual increases in digitalisation amongst businesses, public sector and the IoT.
- However, usage growth only increases by a factor of eight for fixed usage and a factor of 60 for mobile usage.

Figure 77: Fixed and mobile data usage



Source: Deloitte analysis

Appendix B Impacts of digitalisation: methodology

B.1 Methodology for estimation of the economic impacts of enhanced digitalisation

The economic impact for each scenario of enhanced digitalisation is presented as an incremental impact on top of a counterfactual. This means that the counterfactual is subtracted from the total impact in each scenario to provide the additional economic impact due to enhanced digitalisation.

This section first describes the methodology used to construct a counterfactual for key economic indicators. It then describes the methodology used to estimate the incremental impact of each scenario of digitalisation on different economic indicators.

The counterfactual for the Scottish economy

- GDP forecasts for Scotland up to 2030 assume a 2% growth in GDP annually. The division of GDP between urban, semi-urban, rural and remote rural is estimated as 50%, 37%, 9% and 4% respectively and is assumed to be constant throughout.[139]
- Population forecasts for Scotland up to 2030 are obtained from the National Registry of Scotland. The division of population between urban, semi-urban, rural and remote rural is estimated as 34%, 48%, 12% and 6% respectively and is assumed to be constant throughout.[140] Population forecasts are used to construct the GDP per capita trend in the counterfactual.
- Employment forecasts for Scotland up to 2030 are obtained from Oxford Economics data. Total employment is split across urban and rural areas in the same proportion as the population is split between these areas. Employment forecasts are used to construct the productivity (GDP/worker) trend in the counterfactual.
- Data on the number of Scottish enterprises by geography (urban and rural areas) and size (SOHO, SMEs, Large corporations) is obtained from the Office of National Statistics. The historical growth rate of enterprises is applied to obtain an estimate of the number of businesses up to 2030.

Impact of increased digitalisation on GDP

Increased digitalisation is likely to impact economic activity through some key levers, such as increased internet and device penetration and enhanced data usage brought about via new technologies such as cloud computing and big data. The cumulative impact of enhanced digitalisation on Scotland's GDP has been estimated by adding the impact from five levers.

Increased fixed broadband penetration:

The relationship between increased fixed broadband penetration and GDP growth is well established in the literature, with many academic papers attempting to quantify it. This report uses the results of an econometric estimation that Deloitte conducted for BT on the impact of fixed and mobile penetration on GDP in the EU27 and OECD countries over a ten year period up to 2012.[141] It uses this result because the study controls for mobile penetration in the regression for fixed telephony penetration, which leads to a more robust estimate of the impact of fixed penetration.

The econometric relationship is estimated using panel data from 38 countries. To account for potential reverse causality and country fixed effects, a difference Generalised Method of Moments technique is employed. This provides consistent estimates by instrumenting the endogenous variables with all their available lags in differences. The Hansen test of over-identifying restrictions confirms that the instruments are valid. The regression estimates that every 10% increase in fixed line penetration increases annual real GDP by 88%.

[139] Rural Policy Reviews Scotland, UK, OECD Rural Policy Reviews (2008)
[140] The division of population between urban and rural areas currently (as documented in the population tables of the National Registry of Scotland) is assumed throughout till 2030
[141] BT: Enabling the UK economy, Deloitte (2014)

This result is applied to the fixed broadband penetration rates defined in the three scenarios of digitalisation to get the cumulative impact on GDP up to 2030 due to fixed broadband penetration.

Increased mobile penetration:

The econometric estimation Deloitte conducted for BT also finds that a 10% increase in mobile penetration increases annual real GDP by 0.63% for EU and OECD countries, holding fixed penetration constant. This result is applied to the mobile penetration rates defined in the three scenarios of digitalisation to get the cumulative impact on GDP up to 2030 due to increased mobile penetration.

Increased cloud computing usage:

Using the results of a report on the economic impact of cloud computing in Europe that estimates the GDP and productivity gains that can be made by more and more businesses employing cloud computing.[142] The study finds that across Europe's five largest economies (France, Germany, Italy, Spain, UK) widespread adoption of cloud computing has the potential to generate €763bn of cumulative economic benefits over the period 2010 to 2015. This is 1.57% of the approximate total cumulative GDP of the five economies over the same period. For the UK this implies that real annual GDP increases by 0.05% for every 1% increase in cloud computing penetration. This elasticity is applied to the cloud computing penetration rates defined for the different scenarios of digitalisation to get the cumulative impact on GDP up to 2030 due to cloud computing.

Increased big data usage:

This report uses a study by the Centre for Economics and Business Research (CEBR) on how big data analytics can unlock the growth potential of businesses in the UK.[143] The report estimates cumulative benefits of about £216 billion over the 2012-17 time period, which is equivalent to an estimated 2.3% of UK GDP over the same period. This result is applied to the penetration rates of big data in the three scenarios of digitalisation to provide an estimate of the cumulative increase in GDP in Scotland up to 2030 due to big data analytics.

Increased IoT penetration:

The results of a report by the McKinsey Global Institute on the impact of disruptive technologies are used to estimate the impact of increased IoT use across different sectors of the Scottish economy.[144] The following impacts are used: widespread use of IoT is estimated to reduce operating costs in the manufacturing sector by 3.5%, improve sales in the retail sector by 2%, increase yields in agriculture by 15%, reduce operating costs in resource extraction industries by 7.5% and reduce costs due to water and waste management and congestion management by 15% each.

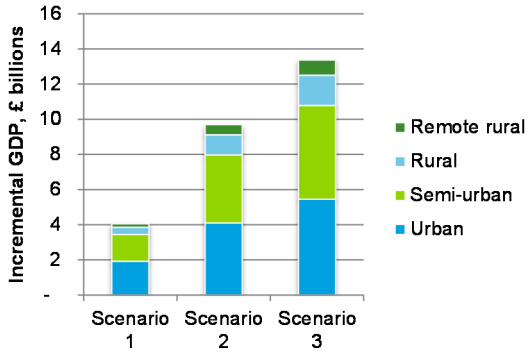
These benefits are assumed to be fully realised in a scenario where Scotland is a world leader in ICT i.e. Scenario 3. The economic impact due to IoT in scenarios with less digitalisation is estimated using the relative number of IoT devices in the scenario compared to Scenario 3.

Input-output tables published by the Scottish Government are used to obtain the gross value added to the Scottish economy by the different industries being considered. As with the GDP in the counterfactual, a 2% annual growth rate is applied to obtain the size of these industries in 2030. This assumes that the underlying structure of the Scottish economy remains the same up to 2030.

The incremental impact on GDP up to 2030 from fixed and mobile penetration, and increased cloud computing, big data analytics and IoT use is added to give the cumulative impact on GDP. The final impact is broken down by urban and rural areas based on the different penetration rates for these areas defined in the scenarios (see Figure 78).

[142] The Cloud Dividend, CEBR (2010)
[143] Data Equity: Unlocking the value of big data, CEBR (2012)
[144] Disruptive technologies: advances that will transform life, business and the global economy, McKinsey Global Institute (2013)

Figure 78: Incremental impact of enhanced digitalisation on GDP



Source: Deloitte analysis

Impact of increased digitalisation on productivity

The literature on economic impacts of digitalisation identifies productivity impacts attributable to broadband penetration and cloud computing. Labour productivity improvements in Scotland due to these two technologies are estimated.

Impact of increased broadband penetration (fixed and mobile) on productivity:

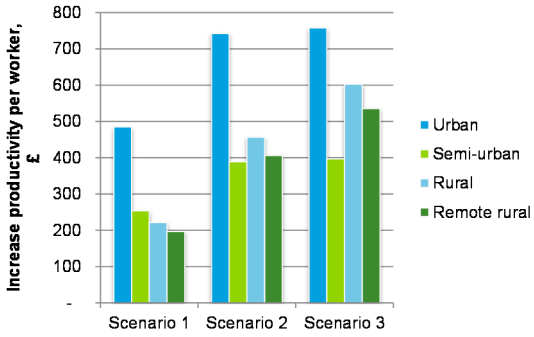
This study uses the results of an economic impact assessment of broadband among 15 OECD countries, 14 European countries and the United States.[145] The impact of broadband penetration (fixed and mobile) on productivity is estimated in a regression framework that controls for voice penetration. The impact is estimated separately for countries with high ICT penetration generally (including UK, Netherlands, USA and others) and low ICT penetration (e.g. Belgium, Greece). Every 10% increase in broadband penetration is found to increase productivity by 1% in medium and high ICT countries.

This elasticity is applied to broadband penetration rates defined in the different scenarios of digitalisation to obtain the cumulative impact on productivity up to 2030 of enhanced broadband penetration.

Impact of cloud computing on productivity:

The study on the economic impact of cloud computing described above finds that average employee efficiency increases by approximately 0.016% for every 1% increase in cloud computing penetration. This result is applied to the different digitalisation scenarios to estimate the cumulative productivity improvement due to cloud computing in Scotland up to 2030.

Figure 79: Impact of enhanced digitalisation on productivity in Scotland



Source: Deloitte analysis

Impact of increased digitalisation on business creation

Impact of increased cloud computing on business creation:

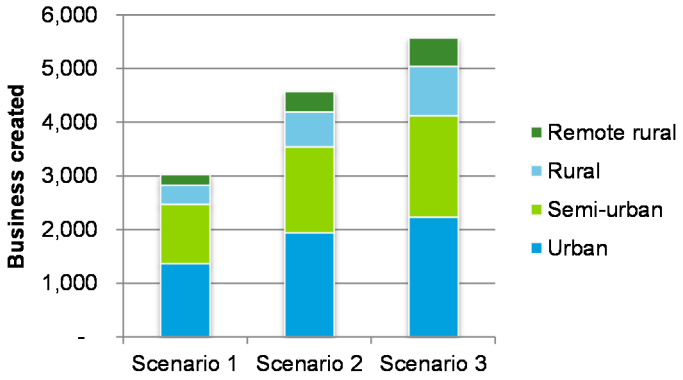
[145] Economic impact of broadband: an empirical study, LECG (2009)

The economic impact assessment of cloud computing discussed above finds that roughly 12% of the total value addition due to cloud computing is attributable to business creation.[146] This information, along with the average value add for SOHOs and SMEs is used to estimate the number of new businesses created by enhanced cloud computing use across the three scenarios.[147]

Impact of increased big data use on business creation:

The economic impact of big data in the study discussed for GDP estimation works through three different channels: increased business efficiency, increased business innovation and increased business creation. The study implies that a 1% increase in the proportion of companies using big data analytics can create new business worth approximately £150m.[148] This result, along with the average value add for SOHOs and SMEs, is used to estimate the number of new businesses created by big data analytics proliferation across the three scenarios.

Figure 80: Impact of enhanced digitalisation on business (SOHO & SME) creation



Source: Deloitte analysis

Impact of increased digitalisation on employment

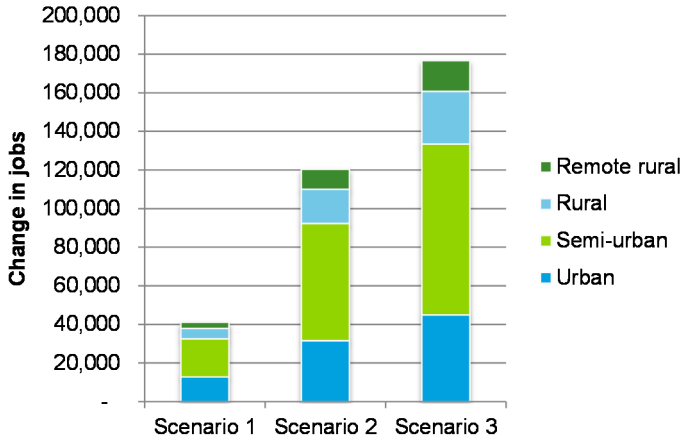
Two different employment effects of enhanced digitalisation are estimated:

- The employment generated by new business creation is estimated by dividing additional GDP due to business creation by the average worker productivity on a yearly basis. The jobs created every year are added to give the total jobs created up to 2030 by new business.
- The employment generated by increased innovation and efficiency of existing businesses is estimated separately. For this, the business creation value addition is subtracted from the total GDP addition to the economy under each scenario and the remaining value addition is divided by worker productivity to give jobs created in existed businesses. The jobs created by existing businesses every year are added up to 2030 to give the cumulative additional jobs.

Employment generated by new and existing businesses is added together to give the total employment generated by enhanced digitalisation across the three scenarios (Figure 81).

[146] The Cloud Dividend, CEBR (2010)
[147] Information on average turnover by firm size is obtained from the Office of National Statistics
[148] Data Equity: Unlocking the value of big data, CEBR (2012)

Figure 81: Impact of enhanced digitalisation on employment



Source: Deloitte analysis

Impact of increased digitalisation on earnings, exports and taxes

The impact of enhanced digitalisation on earnings, exports and taxes is estimated as follows:

- **Earnings**: The increase in earnings is estimated using the total increase in GDP due to enhanced digitalisation in each scenario and applying the income effect reported in the Scottish input-output tables. A weighted average of the income effect by size of the industry is used.
- **Exports**: The proportion of Scottish GDP that is exports (excluding oil and gas exports) currently is estimated using data on exports in the Scottish Global Connections survey 2013. This proportion is applied to the additional GDP in each scenario to estimate the additional exports.
- **Taxes**: Data on Scottish public sector revenue is used to estimate the proportion of total GDP that is tax revenue in Scotland currently.[149]The proportion of tax revenue attributable to tax on income and wealth, NI contributions and tax on production and imports currently is also estimated. These ratios are applied to the incremental GDP addition in each scenario to estimate the additional tax revenue under each scenario.

Time saving impacts of enhanced digitalisation

Three different time saving impacts of enhanced digitalisation have been estimated as follows.

Time saved by remote working:

- The time saving impact of remote working is calculated under the assumption that 20% of workers would be able to work remotely two days per week by 2030.
- The value of one commute in urban and rural areas is different. This value is estimated using average commute time to and from work in urban and rural areas and the market price imputed to time spent commuting by the Department for Transport.[150]
- The value of one commute and the number of employees in urban and rural areas commuting remotely is used to calculate the monetary value of time saved in commuting.

Time saved by online weekly grocery shop:

- The time saving impact of 20% of Scottish households doing one weekly shop online by 2030 is estimated.
- The value of one shopping commute in urban and rural areas is different. ONS data suggests that time taken to reach shops is three times greater in rural areas compared to urban areas. The value of a shopping commute in urban and rural areas is estimated using average distance to shopping centres and the market price imputed to non-working time by the Department of Transport.[151]
- The value of one shopping commute and the number of households in urban and rural areas shopping online is used to calculate the monetary value of time saved from shopping online.

[149] Government Expenditure and Revenues Scotland 2012-13 (GERS)
[150] Data sources include Labour Force Survey 2012, Department for Transport and ONS
[151] Data sources include National Travel Survey, Labour Force Survey 2012, Department for Transport and ONS

Time saved by e-commerce:

- The time saving impact of e-commerce is estimated under the assumption that all Scottish adults buy at least two products online (instead of going to the shops) by 2030.
- The value of a shopping trip in urban and rural areas (as estimated in the online weekly grocery shop calculation) and the number of adults in urban and rural areas in 2030 is used to provide an estimate of the monetary value of time saved by e-commerce.

B.2 Methodology for estimation of the impact of enhanced digitalisation on the health sector

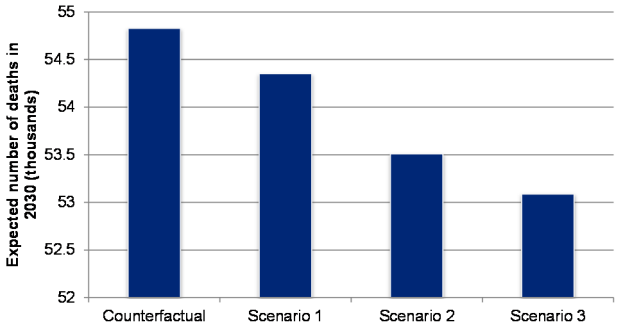
Impact of increased digitalisation on health literacy and lives saved

The impact of enhanced digitalisation on health literacy and mortality in Scotland is estimated using the results of a study published in The BMJ medical journal.

Research undertaken in the UK[152] indicates that health literacy can affect individuals' mortality risk. This research identifies a sample of people aged above 52 and over with three different levels of health literacy: low, medium and high. People with low and medium health literacy are found to have higher risk mortality after controlling for all other factors, by 26% and 7% respectively, compared to those with high health literacy over a five year period. These results are applied to Scotland as follows:

- The study finds the distribution of health literacy in the sample of UK adults to be: 67.2% have high health literacy, 20.3% have medium health literacy and 12.5% have low health literacy. This distribution of health literacy is assumed across adults aged 52 and over in Scotland today.
- Levels of health literacy in the future are assumed to grow in line with broadband take-up rates defined in the different scenarios of digitalisation. This means that by 2030 77% of adults in Scotland can be assumed to have a high level of health if only current trends in internet use continue (the counterfactual), whereas health literacy levels can be assumed to be 83% (Scenario 1), 94% (Scenario 2) and 100% (Scenario 3) in the other scenarios of digitalisation defined in the study.
- Population and mortality rate forecasts published by the Scottish Government are used to estimate the number of deaths in Scotland in the counterfactual in 2030.
- Reduced mortality rates (as indicated by the study described above) are applied to adults with high health literacy in the three scenarios of differing digitalisation to estimate the number of deaths in Scotland in 2030 in the three scenarios.
- The difference in the number of deaths in Scotland between each of the three scenarios and the counterfactual in 2030 gives the incremental number of lives saved due to improved health literacy in each scenario.

Figure 82: Expected number of deaths in Scotland in 2030



Source: Deloitte analysis

Impact of increased digitalisation on chronic disease prevention

The impact of increased use of telemedicine and telemonitoring on mortality rates among those with chronic disease is estimated for Scotland. Various studies document the positive impact of telemedicine on the health outcomes of those with

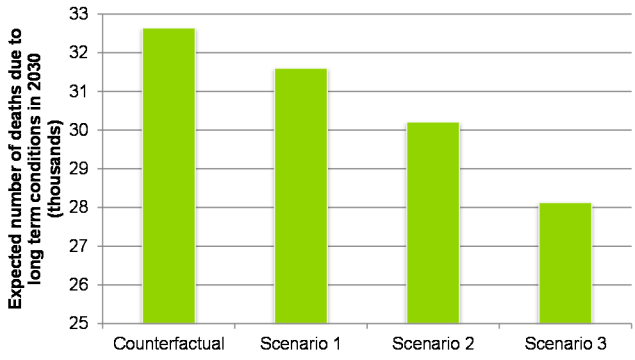
[152] Association between low functional health literacy and mortality in older adults: longitudinal cohort study, The BMJ (2012)

chronic disease. A study reviewing 14 randomised controls of remote monitoring among those with chronic heart disease is used here. [153] A systematic review of these trials finds that structured telephone support or telemonitoring (without regular clinic or home visits) for chronic heart disease patients reduces mortality rates by 20% and rates of admission to hospital for chronic heart failure by 21%.[154]

These results are applied to estimate the impact on mortality and hospital admissions among those with long term conditions in Scotland.

- Different rates of penetration of telemedicine and telemonitoring among those with chronic disease are assumed across different scenarios of digitalisation: 30% of those with chronic disease are assumed to have access in the counterfactual and 45%, 65% and 95% are assumed to have access in Scenario 1, 2 and 3 respectively.
- Population projections of the Scottish Government and current prevalence rates of chronic disease are used to estimate the number of people with chronic disease in Scotland in 2030.
- The current mortality rate among those with long term conditions is applied to people without access to telemedicine in 2030 and a lower mortality rate is applied to those with access to telemedicine in 2030. This gives the number of deaths from chronic illness in 2030 across the different scenarios of digitalisation in Scotland (see Figure 83).

Figure 83: Expected number of deaths due to chronic illness in Scotland in 2030

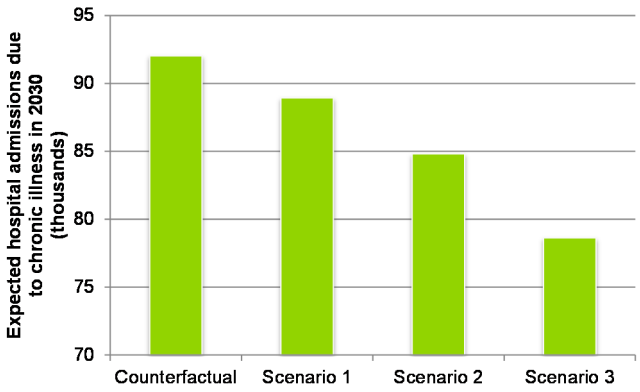


Source: Deloitte analysis

- Different rates of penetration of telemedicine and telemonitoring among those admitted to hospital for chronic disease are assumed across different scenarios of digitalisation: 30% of those with chronic disease are assumed to have access in the counterfactual and 45%, 65% and 95% are assumed to have access in Scenario 1, 2 and 3 respectively.
- Historical data on the number of bed days and average length of hospital stay among those with chronic disease in Scotland is extrapolated to estimate the number of hospital admissions due to chronic disease in Scotland in 2030 (if nothing changes in the status quo).
- A reduced rate of hospitalisation is applied to people receiving telemedicine services in Scotland in 2030. This gives the number of hospital admissions due to long term illnesses across the different scenarios of digitalisation (see Figure 84).

[153] Telemonitoring or structured telephone support programmes for patients with chronic heart failure: systematic review and meta-analysis, The BMJ (2007)
[154] The length of follow-up in the trials considered ranged from 3-16 months.

Figure 84: Expected number of hospital admissions due to chronic illness in Scotland in 2030



Source: Deloitte analysis

Impact of increased digitalisation on cost savings in the health sector

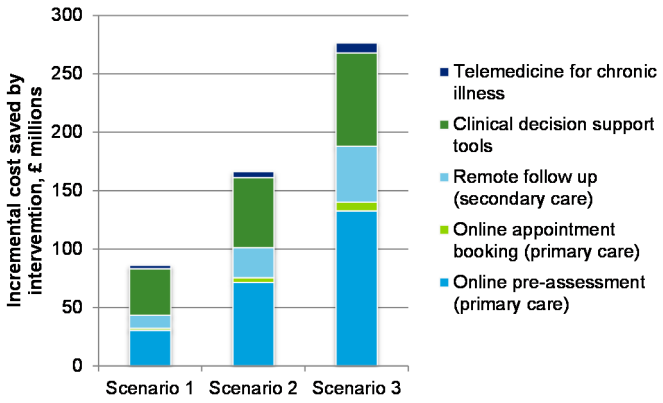
Results from a number of different studies are used to estimate the cost savings from increased digitalisation in the health sector. The impacts of online assessment in primary care, remote follow up in secondary care and online appointment booking in primary care are estimated using the results of an NHS Digital First report which calculates these cost savings for England.[155]

For each of these calculations, 30% of the population or GPs are assumed to have access to remote and video consultation in 2030 in the counterfactual, and 45%, 65% and 95% of the population is assumed to have access in Scenario 1,2 and 3 respectively.

- **Online assessment in primary care**: the historical trend in the number of GPs in Scotland is extrapolated to estimate the number of GPs in 2030.[156] The number of GPs having access to online assessment in primary care is calculated for each digitalisation scenario. Cost saving of £600/year for every GP using online assessment, as estimated by the NHS report, is applied to estimate cost savings across the different scenarios of digitalisation.
- **Remote follow-up in secondary care**: the historical trend in follow-up appointments in Scotland is extrapolated in line with the population growth rate to estimate the number of appointments in 2030.[157] Unit cost saving of £28 per appointment conducted remotely, as estimated by the NHS report, is applied to estimate cost savings from remote follow-up appointments across the different digitalisation scenarios.
- **Online appointment booking in primary care**: the trend in the number of appointments in the primary sector in Scotland is extrapolated in line with the population growth rate to estimate the number of appointments in 2030.[158] Unit cost saving of £0.43 per appointment booked online, as estimated by the NHS report, is applied to estimate cost savings from remote follow-up appointments across the different digitalisation scenarios.
- **Telemedicine for chronic illness**: cost savings due to the reduction in hospital admissions calculated earlier are estimated. Data on average hospital stay and cost of a bed day in Scotland is utilised for the estimation.[159]
- **Reduction in laboratory tests**: the historical trend in laboratory test costs in Scotland is extrapolated to estimate the laboratory costs in 2030.[160] Different cost reductions enabled by clinical decision support tools (ranging from 11% to 22%) identified in the research are applied to the total laboratory costs to estimate cost savings across the different digitalisation scenarios.[161]

[155] Digital First: the delivery choice for England's population, NHS
[156] Data extracted from Information Services Division (ISD), Scotland
[157] Data extracted from Information Services Division (ISD), Scotland
[158] Data extracted from Information Services Division (ISD), Scotland
[159] Data extracted from Information Services Division (ISD), Scotland
[160] Data extracted from Information Services Division (ISD), Scotland
[161] Extrapolating evidence of Health Information Technology savings and costs, RAND Health

Figure 85: Incremental cost savings by different eHealth interventions in Scotland in 2030



Source: Deloitte analysis

Contacts

Tony Rose

Director of Digital

Scottish Futures Trust

Tony.Rose@scottishfuturestrust.org.uk

Davide Strusani

Director, Economic Consulting

Deloitte, London

dstrusani@deloitte.co.uk