

UK SMART CITIES INDEX

FOREWORD

Huawei, a Fortune Global 500 company and a leading provider of global information and communications technology solutions, is delighted to present the first UK Smart Cities Index. As technology develops and transforms how we communicate, consume, interact and work, the ability and potential for Smart City technologies to address some of Britain's most pressing urban challenges – from congestion to crime – becomes ever more important. Harnessing existing data and sharing it across different services will have a profound impact on the way in which cities operate and are run.

In commissioning the UK Smart Cities Index, which assesses how 10 cities across the UK are developing and implementing smart technologies, our aim is twofold: to highlight and celebrate best practice across the UK and to identify policy challenges and barriers which national and local government need to overcome for cities to become smarter.

This is a space we at Huawei know very well. Our global success stories include delivering e-Government, Safe City, Smart Healthcare, Smart Transport and Smart Grid solutions in The Netherlands, Brazil, South Africa, Nigeria, China and Russia amongst others. All of these innovative projects seek to address some pressing urban challenges including healthcare provision, energy efficiency and public safety.

Here in the UK we are actively engaged with partners and cities by planning and deploying a diverse range of Smart City solutions that help to deliver better integrated and more efficient public services to improve the quality of life of all citizens.

The UK Smart Cities Index provides an excellent overview for city leaders and councils, demonstrating how significant Smart City projects can, and have, been implemented successfully up and down the UK and the benefits they have brought to local communities. Since opening our first office here in 2001, Huawei has been actively supporting the development of the UK's technological capabilities and we look forward to continuing our work with the UK Government and the ICT sector, leveraging our knowledge and experience to help the UK take the next step in developing smarter cities over the coming years.

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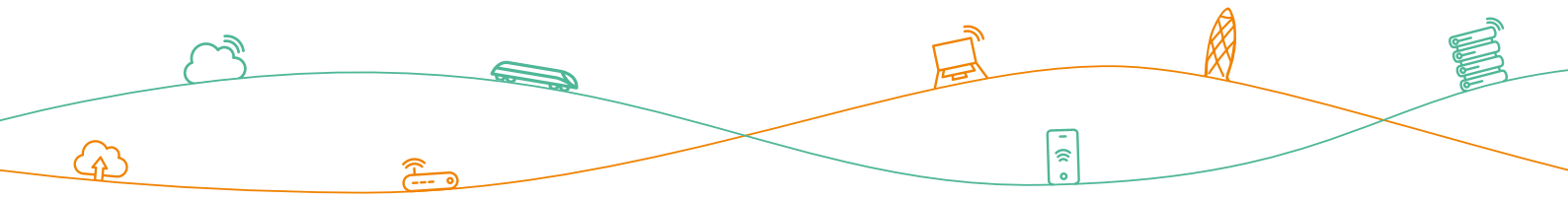



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SECTION 1

EXECUTIVE SUMMARY

1.1 Introduction

Cities are a focal point for some of the most profound economic, environmental, social and technological issues facing the world today. The smart city concept has come to represent the opportunities and challenges facing cities as they respond to these changes. In the UK, a number of cities have become significant proponents of smart city concepts, while many more are now seeking to develop their own smart city plans. UK cities are now playing a significant role in the evolution of smart city ideas globally.

Basic smart city ideas have been accepted, policy and visions have been announced and some exciting technologies have been deployed in extensive pilot and demonstration projects. The challenge now is to show how these solutions can be deployed at scale to the benefit of the wider city population. This is a timely point to assess progress, share successes, showcase key developments, and identify limitations and barriers.

This study reveals the strong commitment of UK cities to innovation and service improvement. Every city in the Smart Cities Index has developed significant programmes and their city leaders have high ambitions over the coming decade. These leaders are setting out plans to use technology and service innovations to deliver more efficient services, meet the needs of ageing populations and to ensure their cities have the infrastructure and skills needed to be competitive in a global economy. In addition, they have established ambitious carbon reduction and resource management goals.

1.2 Background to the Report

1.2.1 Aims of this Study

The aim of the UK Smart Cities Index is to provide an assessment of the current state of smart city development in the UK through a detailed comparison of the 10 leading smart cities. The evaluation highlights their strategies, key projects and overall readiness to develop their smart city visions. The study also highlights lessons to be learnt from these early adopters and areas where cities, the national government and other stakeholders need to act to accelerate smart city development in the UK.

1.2.2 Evaluation Method

The 10 cities were selected on the breadth and depth of their smart or future city strategy and specific programmes in areas such as digital innovation, social care, urban mobility, energy, education and sustainability. The assessment also looks at the extent of their partnerships and collaboration with other agencies and the private sector. A detailed comparison was made of the top 10 cities to identify the current leaders and their closest challengers. The report also highlights the work being done in a number of follower cities that have the potential to be future contenders for smart city leadership in the UK.

The evaluations in this report are based on Navigant Research's corpus of smart city research; public documents on city strategies, projects and performance; interviews with city leaders and project teams; and interviews with other key stakeholders in the development of smart cities from the public and private sector.

THE LEADING CITIES HAVE ESTABLISHED EXTENSIVE SMART CITY STRATEGIES, AMBITIOUS OBJECTIVES AND STRONG LEADERSHIP TEAMS.

1.2.3 Evaluation Criteria

The city evaluations for this Index are based on two dimensions: Strategy and Execution. The Strategy dimension assesses each city's vision, goals and objectives as they relate to its smart city programme. The Execution dimension assesses the city's actual achievements from initial projects to full-blown deployment of innovative technologies and services.

Each dimension is split into five evaluation categories. The evaluation categories for the Strategy dimension are:

- Vision: Assesses the clarity, comprehensiveness and depth of the city's smart or future city strategy.
- Digital Innovation: Evaluates a city's strategy to develop and exploit digital technologies and services.

- **Service Innovation:** Examines a city’s strategy for innovations in local services that exploit improvements offered by smart technologies.
- **Sustainability Plans:** Assesses a city’s sustainability strategy and the explicit targets set for energy consumption, greenhouse gas emissions and related goals.
- **Stakeholder Engagement:** Examines the range of city stakeholders involved in the development of the smart city strategy.

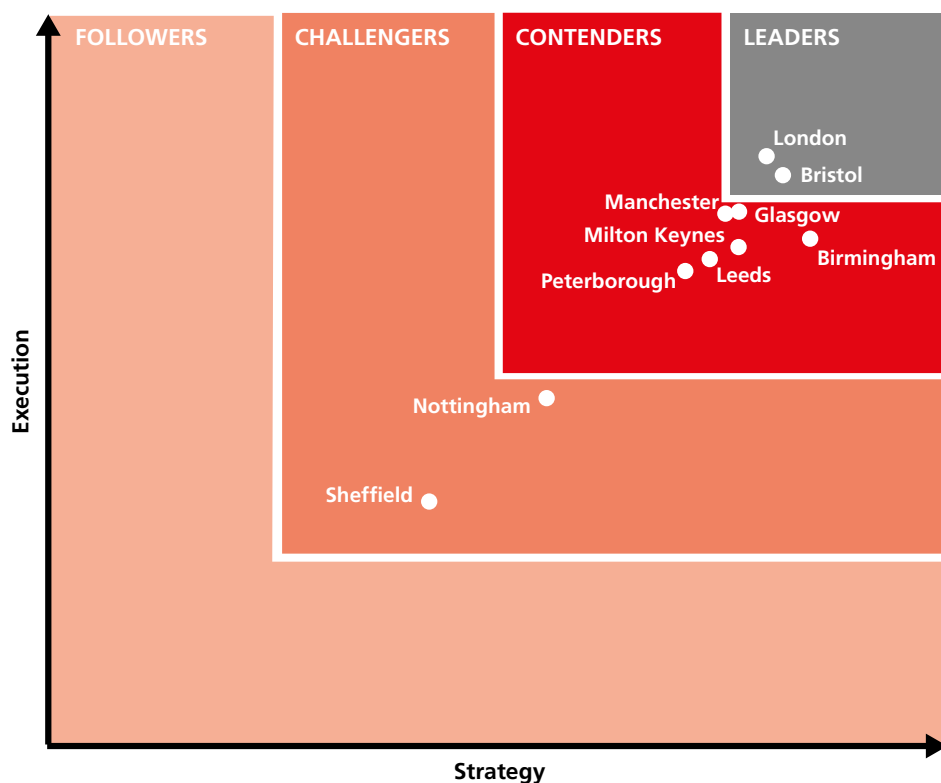
The evaluation categories for the Execution dimension are:

- **Implementation:** Assesses the city’s overall progress in translating its strategy into action based on the number, range and extent of projects implemented to date.
- **Digital Delivery:** Evaluates progress on implementing the city’s digital strategy, including pilot projects, smart city demonstrators and full-scale projects.
- **Service Delivery:** Evaluates progress on implementing service innovations defined in the city’s smart city strategy.
- **Environmental Impact:** Looks at achievements against sustainability targets and implemented environmental and sustainability programmes.
- **Community Reach:** Assesses engagement across multiple communities and stakeholders and the extension of projects into the wider city region.

Navigant Research scores the cities in the UK Smart Cities Index according to four categories: Leaders, Contenders, Challengers, and Followers. These categories are defined below.

- **Leaders:** These cities have differentiated themselves through the clarity, breadth, and inclusiveness of their smart city vision and planning. They are also leading the way in implementing significant projects at both the pilot and, increasingly, full-scale levels.
- **Contenders:** These cities have done much to establish their smart city strategies and have implemented some significant projects. However, there are still some gaps in their strategies and the number of actual projects may fall behind that of the smart city Leaders.
- **Challengers:** Challenger cities have laid down a vision for their smart city endeavours and begun to deploy projects, but execution still trails the vision outlined. They may have shown strong initiative in a few key areas but with less breadth in their programme than the leading cities.
- **Followers:** These are cities that are beginning their smart city journeys. They may have made initial statements of intent and begun limited pilot projects and siloed operations, but they need to develop a more integrated view for city development and/or stronger leadership for their programmes.

Chart 1.1 UK Smart Cities Index



(Source: Navigant Research)

1.3 The UK Smart Cities Index

1.3.1 Summary of Rankings

Two cities are identified in the Navigant Research rankings as Leaders in the process of becoming smart cities: London and Bristol. Both cities are combining technical innovation with a broader strategy for city development.

Behind the Leaders in the Index are a group of cities that are Contenders for leadership positions. Manchester, Birmingham, Glasgow, Leeds, Milton Keynes and Peterborough are all developing strong smart city programmes and driving innovation in a number of areas.



Manchester has been investing in digital innovation for many years. The Manchester Corridor is becoming a site of focused innovation. The current EU-funded and energy-focused Triangulum project will soon be complemented by the UK government-funded Internet of Things (IoT) Demonstrator. The city's ambitious plans as a showcase for the devolution of city powers, which will lead to an elected mayor for the city region in 2017, also provide a distinct framework for its smart city programmes.

Glasgow now has the opportunity to build on the projects it developed with support of the Future City Demonstrator award. The city is identifying projects that it will take forward and is sharing ideas with other Scottish cities as part of the Smart Cities Scotland programme.

Leeds has set out ambitious plans to be the best city in the UK by 2030 and in particular wants to be the best city in which to grow old. Its work on the Leeds Data Mill and on joint social and health care projects, as well as digital inclusion for the elderly, are notable steps towards this goal.

Birmingham has developed an extensive smart cities vision and strategy that it is marrying with its digital innovation programme. Its plans to make the East Birmingham area of the city a testbed not only for technology but also for community engagement provide a strong basis for turning that vision into real city improvements.

Peterborough is utilising technology platforms to support its smart city vision but has impressed most of all in its work with local communities in the development of its Circular City vision, which promotes reuse, energy efficiency, innovation, and collaboration.

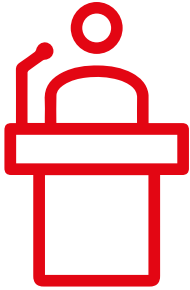
Milton Keynes is establishing itself as a testbed for new urban technologies with its IoT projects and autonomous vehicle trials. Consciously designed as a laboratory for urban innovation, the onus is on the city to take the successes from MK:Smart and find the means to turn them into larger-scale projects. The development of the MK:Smart Data Hub is an investment that should provide wide-scale benefits to multiple projects across the city.

London has been a pathfinder for a number of urban innovations, including the London Congestion Charge and other low-carbon transport programmes, an ambitious climate plan and energy programme, and a strong commitment to open data and the use of data analytics. London's infrastructure investment, innovation culture, and ability to attract investment are also notable factors in its ranking.

Bristol's smart city strategy is connecting technical innovation and priority issues for the city and its communities. Bristol Is Open is a unique project that can put the city among the global leaders in urban innovation projects. The city is also a leader in open data access, energy innovation, and imaginative forms of community engagement.

1.4 Key Messages for City Leaders

The experience of the cities assessed in this report provide valuable insights for other cities embarking on a smart or future city initiative or looking to ramp up existing projects. In particular, five themes are common across the most successful smart city programmes.



1.4.1 The Importance of Leadership and Vision

Strong leadership from the city council and executives is vital to developing a coherent and sustainable smart city strategy. Vision statements and smart city roadmaps can provide shared goals and clear targets, but they have to be matched by a commitment to

implementation and to building on successful pilots.

The leading cities have not only produced a guiding vision for a smart or future city, they are also embedding these ideas into their programmes for service improvement and capital investment. There is strong leadership from the top and clear accountability for delivering the plan.

Smart city teams also need to work with city leaders and managers to ensure a common understanding of the key objectives for any smart city programmes as well as the opportunities and challenges. The goal should be to embed the idea of smart capabilities into most major projects or service redesigns.



1.4.2 Focus on Local Priorities and Strengths

There are many different opportunities for the use of smart technologies to address city challenges. Each city will have its own priorities in terms

of social, environmental, and infrastructure challenges, but it will also have distinct strengths in terms of skills and resources. Successful smart city programmes are building on those assets to develop a distinct smart city vision that is aligned with local needs and goals. Peterborough's Circular City concept and Milton Keynes' focus on technology innovation are good examples of how two of the smaller cities are combining smart city objectives with the development of a distinct modern identity. On a different scale, Bristol, Manchester, and Birmingham are also leveraging local strengths to good effect.



1.4.3 Engagement with Communities

A smart city strategy that does not engage with local communities has little chance of long-term success. Cities need to work with local communities in all aspects of their

smart city programmes, from initial strategy to project design, deployment, and data collection. The cities in this study are developing new approaches to community involvement with an emphasis on the co-creation of services and on digital inclusion programmes for residents and small businesses. Today, these programmes are only reaching a small percentage of the city population, but such exercises are providing blueprints for wider engagement.

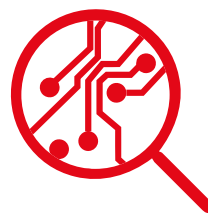


1.4.4 Building Partnerships

Smart city solutions can only be delivered through a network of partnerships. The leading cities are notable for their ability to bring together public

sector agencies, the private sector and academia. Corridor Manchester is a good example of how these three streams can be brought together to drive innovation and transformation. MK:Smart is also notable for its ability to attract a range of private sector investors and to leverage the capabilities of The Open University. Bristol Is Open is another project that is developing new models of collaboration between the city, the university sector, and a range of global and local businesses.

The creation of strong partnerships is a particularly important development when it comes to the embedding of smart or digital approaches in significant capital projects. Birmingham's initiatives to ensure the benefits of High-Speed 2 (HS2) investment in the city is a good example of what this might entail. The plans being developed for Old Oak and Royal Park in London are another example of integrated thinking around major developments.



1.4.5 Understand the Data Revolution

All of the cities assessed in this report are looking at how they can better use data to improve services and boost innovation. The rapid growth

in the number of sensors and other intelligent devices deployed across the city landscape is creating an immense amount of new data that cities need to manage and learn to exploit to the benefit of all.

An important focus now is to build on the first evolution of open data platforms. Several cities are looking to create data hubs that enable a broad range of stakeholders to share information and make it easier for diverse providers - from both the public and private sector - to use that data to deliver new insights and services. The development of robust data sharing platforms is one element of this strategy, but equally important is the capacity to understand the importance of this data for policy development and the creation of new services.

1.5 Messages for Central Government

The UK government has played an important role in building momentum behind smart cities across the country. The Future Cities and IoT demonstration programmes have provided seed funding for the winning cities and have also driven interest in other cities across the country. The establishment of the Future Cities Catapult has ensured continuity of the interest first generated through the Future Cities Demonstrator. The work on smart city standards has also enhanced the global visibility of UK initiatives.

In general, smart city project teams are keen to see more local devolution of responsibility to enable further innovation to meet local needs, as long as that is matched with a devolution of funding. However, there is still a need for central government support. In particular, there are three key areas where central government (in collaboration with cities and the supplier community) can help further accelerate smart city adoption.

1.5.1 Supporting the Move to Large-Scale Deployment

The most important financial challenge for the faster deployment of smart city solutions is bridging the gap between funding for demonstration projects and full-scale commercial deployments. While demonstrator funding has been helpful in kick-starting technology projects, it is still not clear how this evolves into the broader adoption of smart city technologies. The government should look at how it can help bridge the gap between initial pilots and wider adoption.

THE MOST SIGNIFICANT CHALLENGE FACING ASPIRING SMART CITIES IS HOW TO TRANSITION SUCCESSFUL PILOTS INTO FULL-SCALE PROJECTS.

One important development advocated by a number of smart city leaders is that future demonstration projects have a strong emphasis on both measurable outcomes and supporting business cases. The shift has to be from proving the viability of the technology to showing its social and economic benefits.

One challenge is that the relatively small scale of most pilots makes it difficult to build that substantial business case. Central government should examine what further funding or support can help ensure that momentum is not lost after the success of these initial projects.

Suppliers are also frustrated at the gap between pilot projects and the move to commercially sustainable models. There is an opportunity for government to facilitate engagement between cities, suppliers and cross-industry groups like SmarterUK to explore how they can better manage the risks associated with large-scale deployments.

1.5.2 Encouraging Collaboration and Knowledge Sharing

One approach to accelerating the broader deployment of smart city solutions would be to ensure future demonstration projects have a built-in mechanism to support dissemination of proven models to other cities. This model is being adopted with the European Commission's Lighthouse projects, which identify pathfinder cities for large-scale demonstrations and a group of follower cities that are committed to replicating successful solutions.

Sharing of ideas between smart city projects is already happening across the UK on a city-to-city basis and through the Future Cities Catapult. However, there is an opportunity for this sharing to occur on a more formal basis. The leader/follower model for demonstration projects is one approach.

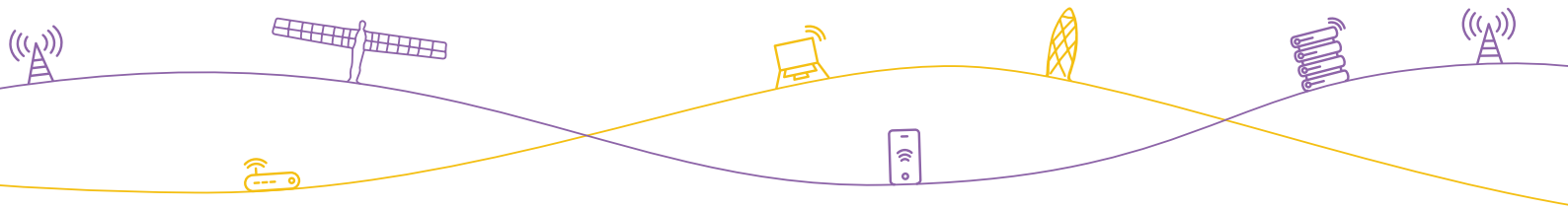
Another possibility is the creation of a forum or clearing house for sharing more detailed insights on pilot and demonstration projects. For example, cities that have run advanced technology trials could work with cities that want to explore these solutions in an operational context.

1.5.3 Investing in Digital Infrastructure

Cities are improving their communications infrastructure and extending broadband access, but there are still important gaps. City leaders, central government and the communications industry need to work together to develop necessary citywide infrastructures. In addition, further work is needed to ensure the accessibility of services to all residents and to small businesses.

The success of the SuperConnected Cities voucher scheme to help extend broadband access in cities, particularly for small and midsize enterprises (SMEs), suggests that there is still a strong demand for more support to extend connectivity in most cities.

Government and city leaders are constrained by market rules in the support they can provide, but the leading cities are showing that there are opportunities to collaborate with suppliers and to better utilise city assets to improve their communications infrastructures. Government should be looking at how it can build on the SuperConnected Cities programme and ensure no cities or communities are left behind.



SECTION 2

THE RISE OF THE SMART CITY

2.1 The Importance of Cities

According to the United Nations, the number of people living in cities will increase from 3.6 billion to 6.3 billion between 2010 and 2050, meaning that 70% of the global population will be urbanized by 2050. The growth in the urban population in just these four decades will be equivalent to the size of the urban population achieved throughout all prior periods of human history. Almost 3 billion additional people will require electricity, clean water and sanitation, efficient transport, homes and public services such as health, education and public safety. Meanwhile, cities in the developed world are looking to improve their economic viability and sustainability. More specifically, they are looking at how to achieve these goals in the context of growing global competition, limited financial resources and ageing infrastructure. How cities can address these challenges and deliver services in an economically viable and environmentally sustainable manner is the question at the heart of the smart city movement.

2.2 Defining the Smart City

The smart city is a simple label for the complex forces shaping urban life in the 21st century. In Navigant Research's definition:

"A smart city is characterized by the integration of technology into a strategic approach to sustainability, citizen well-being and economic development."

Technological innovation is a driver for the evolution of cities and a vital support for those looking to find new ways to manage resources and deliver services. Smart cities are being built on an intelligent urban infrastructure of connected devices. Ubiquitous communication services and the growing use of sensor technologies across the urban fabric are providing cities with new insight into how they operate. Much of the promise of the smart city depends on the ability to deploy, manage, and access the data from these devices and other embedded technologies to drive a new range of services. Smart cities are becoming one of the most important testing grounds for the Internet of Things (IoT), enabling any element of the city architecture to become a potential source of data and a means of fine-grained control, thereby opening up a host of new opportunities for city management and services.

These technology innovations are being harnessed to three core policy objectives common to almost all smart city strategies:

- Sustainability is accepted as one of the critical goals for the modern city. Cities have historically drawn on the energy and material resources of a much larger local, national and global environment. It is no longer possible for a city to disregard how it obtains and uses such resources. Sustainability programmes cover a wide range of ambitions including reduced energy consumption, increases in local renewable energy generation, improvement in waste recycling and water consumption, and changes in transport patterns. The smart city aims to combine sustainability targets with continued improvements in services for its inhabitants and visitors and the continued development of the local economy.
- Citizen well-being covers the broad range of functions and services that citizens expect from their city authorities and other providers. City leaders are only able to deliver change programmes if they can assure citizens that the programmes will lead to an overall improvement in their quality of life through improvements in public services. These services include public safety, health and social care, education, waste management, street lighting and efficient transport systems.
- Economic development is an intrinsic part of a city's ability to deliver better services and to meet its sustainability goals. A defining characteristic of the smart city movement is the importance given to the evolution of a city's industries and commercial activities. Cities need to be centres of digital and clean technology innovation in order to provide employment and attract new businesses and new talent.

2.3 A Global Development

City leaders all over the world have embraced the smart city concept with enthusiasm. They are heralding innovative projects and laying out a vision for how cities can use technology to meet sustainability goals, boost local economies and improve services. It is this commitment to changing how cities operate that is driving continued interest in smart cities.

The staggering rate of expected urban growth in Asia and Africa over the next 40 years is one of the prime drivers for this interest, along with recognition of the importance of cities to economic regeneration in North America and Europe. In Latin America, cities are trying to address decades of underinvestment in their urban infrastructure in order to boost development. Meanwhile, Japan is developing new ideas related to the nature of energy-efficient and resilient communities. Cities are playing a leading role in the mitigation of climate change and are increasingly focused on improving global adaptability to address its consequences. Demographic, economic, and environmental changes are amplified—and in some cases driven—by the rapid changes in the technological fabric of the modern city.

The smart city is also evolving as a concept as many more cities, national governments and technology and service providers add their voices to the discussions. There is a growing emphasis on resilience and climate adaptation in city strategies; a new focus on making smart city development relevant to citizens and their daily lives; a desire for more data-driven policymaking and operational control; and a recognition of the need for standards to help drive smart city programmes to the next stage.

- Amsterdam, Barcelona and Singapore have led the way in developing broad strategies that are driving continuous innovation programmes across many aspects of city life including energy efficiency, urban mobility, public safety and the use of advanced communications and data analysis technologies.
- Lyon in France and Yokohama in Japan are good examples of cities that are looking at how technology enables better energy management across a city, spanning both the public sector as well as commercial and residential use. In the Middle East, Dubai has instituted a smart city programme that has a strong emphasis on energy infrastructure as well as improvements in water, transport, and government services.
- Copenhagen and Dublin are examples of cities that are moving beyond the publication of government open data policies to the exploitation of a wide range of data sources and the establishment of city platforms for information sharing and the use of advanced analytics.
- Cities around the world are leading the drive to reduce greenhouse gas emissions. Copenhagen has one of the most ambitious carbon reduction goals, with the

city aiming to be carbon neutral by 2025. The COP21 conference in December 2015 saw around 80 city and state leaders committing to emissions reduction goals of at least 80% by 2050.

- Urban mobility is another priority for many cities and is driving interest in low-carbon and multi-modal transport strategies supported by new technologies. Helsinki, for example, has instituted a programme to explore the possibilities for citywide on-demand travel that would remove the need for private vehicles.

2.4 Smart Cities in the UK

UK cities are playing an increasingly significant role in the global development of smart cities. A number of cities were early adopters of digital strategies and of sustainability programmes, but it was the £24 million Future Cities Demonstrator competition that acted as a catalyst for much broader engagement. Glasgow was announced as the winner in January 2013, but other cities have also used their submissions as a foundation for their own ongoing programmes. Since then, the leading cities have been extending their smart city plans and integrating them more closely with their broader development strategies.

The move toward smart cities is also connected to the more general debate taking place as to the relationship between the largest cities and the central government. Much of this debate has focused on the potential to create a so-called Northern Powerhouse, based on greater devolution for the larger cities of northern England. Manchester has been the pathfinder for this development, but cities like Leeds, Sheffield, Newcastle and Liverpool are expected to follow this path. Scotland has also been developing its own approach to city development with the establishment of Smart Cities Scotland, spanning the seven largest Scottish cities. The announcement by the Welsh government of a new city deal for Cardiff further reflects the widespread focus on urban innovation across the UK. These developments are also taking place during a sustained period of unprecedented cuts in city budgets, which is forcing city leaders to examine all aspects of city operations in the search for increased efficiency and cost savings.

While local innovations and greater autonomy are key themes for smart city development, cities have also benefitted from a significant commitment to city innovation by the central government. The Future City Demonstrator award has had a significant impact and was accompanied by the establishment of the Future Cities Catapult, a centre of excellence to help boost innovation in cities and to support UK businesses targeting this sector.

The UK has also been a leader in smart cities standards with the launch of its own smart city framework in February 2014. Developed under the aegis of the British Standards Institution (BSI) and with the encouragement of the Department for Business, Innovation & Skills (BIS), the framework was developed by a group of stakeholders

from cities, governments, and suppliers. The Smart City Framework – Guide to Establishing Strategies for Smart Cities and Communities is a guide for city leaders instigating a smart city strategy, with an emphasis on practical steps and a conceptual framework that will help them benchmark progress. The initial report has been followed by specific studies to provide support in areas such as interoperability and data sharing and by the creation of the City Standards Institute within the Future Cities Catapult.

2.5 Assessing the State of Smart Cities in the UK

The UK Smart Cities Index provides a snapshot of the development of smart city programmes across the leading cities at the beginning of 2016. Detailed assessments of the top 10 cities are provided in Section 6, but some general trends are apparent across the evaluation criteria.

2.5.1 Strategy and Leadership

The leading cities have established extensive smart city strategies, ambitious objectives and strong leadership teams. Birmingham, for example, has produced a smart city roadmap based on initial input from its Smart City Panel and local consultation. Other cities have developed strategies that match their specific requirements. For example, Bristol, Milton Keynes and Manchester have developed strong technical innovation platforms. In contrast, Peterborough has focused on a range of projects to link local communities and businesses in what it refers to as the Circular City. The scale of London's challenges and opportunities is reflected not only in its Smart London strategy but also in the comprehensive London Infrastructure Plan.

2.5.2 Digital Innovation

The cities covered in this report have launched many technology projects that are testing the possibilities for urban innovation. Glasgow's award to develop a Future City Demonstrator has enabled it to develop a wide range of projects. Two other programmes—Bristol Is Open and Milton Keynes' MK:Smart—are also notable for their ambition and range of current and potential projects. Manchester, recently awarded funds for an IoT Demonstrator programme, has been involved in several pilots, including the EU-funded Triangulum project.

Several cities also have ambitious plans for their city data platforms. London has led the way with the London Datastore, but other cities are catching up, with Leeds, Glasgow and Bristol all having already established substantial platforms. Birmingham, Milton Keynes and Peterborough also have plans for data platforms that will act as information brokers for public and private sector data providers.

Cities are also investing in their digital infrastructure, with a number of cities providing free Wi-Fi in city centres and public buildings (including Birmingham, Leeds

and London). Bristol with its multi-application urban laboratory network and Milton Keynes with its IoT project again stand out for pushing the boundaries of what a city network may look like in the future.

For many cities, the investment in digital infrastructure is also part of a strategy to increase local skills and bring in new investment in order to develop the local digital economy. London's Tech City cluster is probably the best-known initiative, but other cities are also expanding their local digital economies in collaboration with local and international companies.

It is important that cities ensure that all sections of the community benefit from smart city solutions. The cities covered in this report have programmes to address digital exclusion through training and active engagement. Many are developing co-creation programmes to involve residents and small businesses in the design of new services and the application of new technologies. Leeds' work with the older community in the city is notable in this regard. Bristol is also working to involve communities in the design and use of sensor technologies with its Citizen Sensor project.

2.5.3 Service Innovation

The main driver for investment in smart city technologies is to enable cities to deliver better and more efficient services. This means that digital innovation has to be matched with service innovation. These new approaches span all aspects of city operations, including the use of telehealth and telecare to support social services, smart parking to reduce congestion, intelligent street lighting to reduce energy costs, and information services that allow residents and local businesses to be more involved in shaping their cities. Leeds' ambition to be the best place to grow old in the UK, for example, is driving a number of projects that look at the impact of technologies on services for older residents. On a different theme, Peterborough's strategy for the creation of a Circular City is being supported through a collaboration platform that links local businesses and communities in order to improve energy efficiency, reduce resource consumption and help boost the local economy. For transport, London has led the way with a number of groundbreaking investments including congestion charging, a unified payment card, smart parking, bike sharing and access to extensive transport data.

2.5.4 Sustainability

UK cities have set a range of ambitious targets to reduce their carbon emissions and improve their use of resources. Most cities are committed to meeting the national goal of an 80% reduction in carbon emissions by 2050, but there is considerable variation in their short- and medium-term targets. Bristol has established its international credentials as the European Green Capital in 2015 and Peterborough was awarded the city prize at the Barcelona Smart City Expo in 2015 in part for its work to establish itself as the UK's Environment Capital. London, Bristol

and Nottingham are notable for their efforts to take more control over local energy production and consumption as part of their carbon reduction programmes. Manchester and Birmingham are among the cities also looking at new city energy ventures.

While these efforts are all laudable, there are still significant challenges for cities in reducing their emissions and improving air quality. Recycling levels are still disappointing, though this is an area that Leeds and Peterborough have been successfully targeting. Water is also becoming a more important resource issue for cities with regards to water shortages and the risk of flooding (the latter unfortunately further highlighted by severe weather events in December 2015). Peterborough and Leeds are among the cities already working closely with local water companies to address these problems.

2.5.5 New Partnerships

An important facet of city strategies is the extension of their partnership arrangements with both the public and private sectors. Close relationships with academia are a notable attribute of most smart city programmes. Bristol, for example, is making use of Bristol University's supercomputing facilities as well as relying on it to help manage its new experimental communications network. Milton Keynes has forged a close relationship with The Open University, which is playing a lead role in MK:Smart. Leeds University is also closely aligned with the city of Leeds' strong emphasis on city data and analytics. Successful cities are also establishing strong relationships with key business partners that include global technology players, local companies and city service providers. Both London and Birmingham, for example, have engaged with a range of stakeholders to establish broad-based advisory committees for their smart city strategies.

2.5.6 Demonstration Districts

Several of the leading smart cities have identified specific areas of the city to test a variety of solutions, such as Corridor Manchester, East Birmingham, Knowle West in Bristol, and Smart Fengate in Peterborough. This focus allows for a better understanding of the opportunities and challenges of integrating multiple solutions and technologies. It also allows smart city teams to build closer relationships with a community and thus build trust and understanding. The selection of such districts is influenced by the primary goals of the project and the insights that can be obtained. University districts, for example, offer an excellent base for testing new technologies. Focusing on more deprived sectors of a city can shift the focus to community engagement and social benefits, while projects in a business district can be used to develop innovation programmes and business-to-business collaboration. The true test is to take the lessons learnt in these selected districts and apply them across other communities, a challenge the leading cities are just beginning to address.

2.6 Challenges and Barriers

While the leading cities have some impressive success stories to tell, smart city developments are still relatively immature. There are several issues that both the leading cities and those following them need to face.

2.6.1 Moving Beyond Pilots and Demonstration Projects

While there is considerable activity across the leading cities, many of these projects are based on specific funds such as the UK Future City Demonstrator programme or EU R&D funds. The next step is to establish business cases that allow for the wider deployment of smart solutions. This also implies cities are able to access the capital or develop public-private partnership models that enable this investment.

The city assessments in this report identify an extensive set of demonstration projects; however, there are still few examples of such projects developing into large-scale, economically sustainable projects that benefit a wide range of service users. The most significant challenge facing aspiring smart cities is how to transition successful pilots into full-scale projects. This will require cities and their delivery partners to work together to look at funding sources for initial investment and to develop well-founded business cases.

It is important that future pilots and demonstration projects be designed to test business cases and real outcomes as much as technical feasibility. Shifting the focus to the delivered benefits should make the path from pilot to wider deployment clearer for those projects that prove their worth.

2.6.2 Financial and Resource Constraints

Local authorities are working under extremely tight financial settlements and are expected to continue to do more with less over the coming years. This situation restricts the ability of cities to provide their own upfront funding for demonstration projects and makes the transition to commercial operations more difficult. Conversely, it is incentivising cities to find more efficient means of delivering services and reducing costs.

One of the biggest challenges that a reduction in funding presents is in the lack of free resources in delivery departments able to work on innovation projects. Smart city and digital teams need experts in social care or transport, for example, who they can work with to deliver new solutions with long-term benefits. These resources can be hard to find when departments are already tightly squeezed for staff and time.

One option for cities is to make better use of underused assets and to get maximum value out of new capital programmes. Peterborough is doing this through its platform for local businesses to cooperate on sharing resources. Another approach is that being taken by Birmingham, which is developing a strategy to ensure it maximises the investment being made in the High-Speed 2 (HS2) rail connection in terms of community benefits, integration with local infrastructure and a forward-looking strategy for the use of smart technologies.

2.6.3 Extending Partnerships and Breaking Down Silos

Like all large organisations, cities need to overcome the barriers created by siloed working. An additional advantage of open data policies and integrated platforms is that they enable easier sharing across departments and can support new forms of collaboration. Greater devolution of power to city regions also opens up possibilities for more integrated approaches to social and healthcare services, regional transport and shared services, including those for digital infrastructure and data platforms.

In order to deliver the benefits of smart city technologies, cities are also reliant on their service partners and utilities. Several cities are now working with their local utilities to understand how they can share more data to improve services and to extend local data platforms. Cities also need to collaborate with existing outsourcing providers and consider how future contracts should be structured in order to incentivise innovation.

2.6.4 Digital Infrastructure

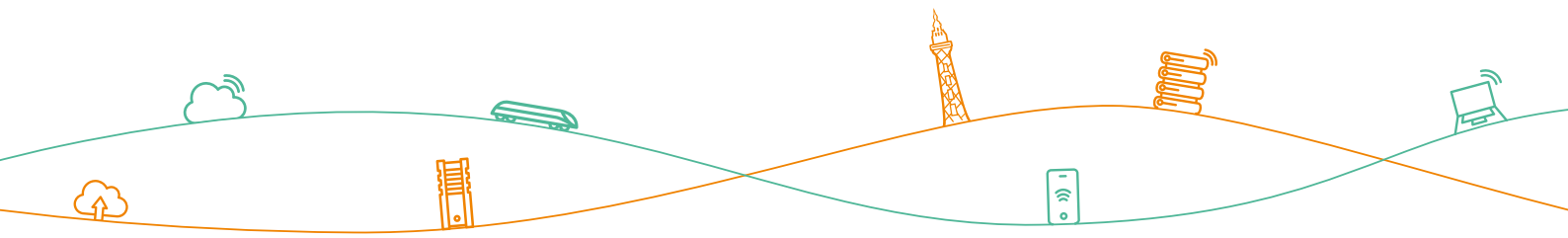
Cities are making important strides in deploying broadband communications, but there is still much to do. The smart city leaders were active in encouraging business take up of the SuperConnected Cities voucher scheme, which has now ended. Cities will benefit from the wider rollout of 4G networks, high-speed fixed broadband services and low-power networks, but city leaders, central government, and the communications industry need to ensure that the right options are in place to further develop citywide infrastructure. Further work is also needed to ensure the accessibility of services to all residents and to small businesses.

2.6.5 Education and Understanding

The broad nature of the smart city concept can lead to misunderstanding and confusion. Smart city teams need to work with city leaders and managers to ensure a common understanding of the key objectives for any smart city programme, as well as the opportunities and challenges. The goal should be to embed the idea of smart capabilities into most major projects or service redesigns so that the city is able to benefit from both short- and long-term gains from a focus on data and connectivity.

Cities also need to engage local communities in all aspects of their smart city programmes, from initial strategy to project design and deployment. The leading cities are developing new models to involve their communities with an emphasis on the co-creation of services and digital inclusion programmes that show the local value of better data and the benefits of smart technologies.





SECTION 3

BACKGROUND TO THE ASSESSMENT

3.1 Aims of This Study

The aim of the UK Smart Cities Index is to provide an assessment of the current state of smart city development through a detailed comparison of the 10 leading smart cities. The evaluation highlights their strategies, key projects and overall readiness to develop their smart city visions. The study also highlights lessons to be learnt from these early adopters and areas where cities, the national government and other stakeholders need to act to accelerate smart city development in the UK.

3.2 Evaluation Method

The 10 cities were selected on the breadth and depth of their smart or future city strategy and specific programmes in areas such as digital innovation, social care, urban mobility, energy, education and sustainability. The assessment also looks at the extent of their partnerships and collaboration with other agencies and the private sector. A detailed comparison was made of the top 10 cities to identify the current leaders and their closest challengers. The report also highlights the work being done in a number of follower cities that have the potential to be future contenders for smart city leadership in the UK.

The city evaluations in this report are based on Navigant Research's corpus of smart city research; public documents on city strategies, projects, and performance; interviews with city leaders and project teams; and interviews with other key stakeholders in the development of smart cities from the public and private sector.

3.3 Evaluation Criteria

The city evaluations for this Index are based on two dimensions: Strategy and Execution. The Strategy dimension assesses each city's vision, goals and objectives as they relate to its smart city programme. The Execution dimension assesses the city's actual achievements from initial projects to full-blown deployment of innovative technologies and services.

Each dimension is split into five evaluation categories. The evaluation categories for the Strategy dimension are:

- **Vision:** Assesses a city's smart or future city strategy, including an assessment of the clarity, comprehensiveness and depth of the strategy. An assessment was also made of the leadership commitment in each city and the level of engagement with all stakeholders.
- **Digital Innovation:** Assesses a city's strategy to develop and exploit digital technologies and services, including plans for the development of the city's communications infrastructure, its open data policy, digital inclusion strategy and plans for developing the local digital economy.
- **Service Innovation:** Assesses a city's strategy for innovation in local services that exploit improvements offered by smart technologies, including plans in the areas of council services, social and health care, education and skills, and transport and urban mobility.
- **Sustainability Plans:** Evaluates a city's sustainability strategy and the explicit targets set for energy consumption, greenhouse gas emissions and related goals in the areas of waste management, transport programmes, air quality and other environmental initiatives.
- **Stakeholder Engagement:** Examines the range of city stakeholders involved in the development of the smart city strategy, including citizen engagement programmes, business involvement (particularly local small and midsize enterprises [SMEs] but also significant partnerships with larger players), and the involvement of local universities and other research organisations.

The evaluation categories for the Execution dimension are:

- **Implementation:** Assesses the city's overall progress in translating its strategy into action based on the number, range and extent of projects implemented to date. It also assesses forward momentum in terms of projects in progress and the near-term pipeline for new projects and programmes.
- **Digital Delivery:** Evaluates progress on implementing the city's digital strategy, including pilot projects, smart city demonstrators and full-scale projects spanning all forms of digital innovation including IoT projects, open data platforms and other big data programmes, digital inclusion projects and improvements to the city's communications infrastructure.
- **Service Delivery:** Evaluates progress on implementing service innovations defined in the city's smart city strategy, including improving access to core services, innovative projects for social and health care, improvements in skills and education related to the use of digital technologies, urban mobility innovations, innovation to support local businesses, and programmes aimed at providing improved information and services for visitors and residents.
- **Environmental Impact:** Looks at achievements against sustainability targets and implemented environmental and sustainability programmes, including smart energy projects, low-carbon transport initiatives, energy efficiency programmes (such as smart street lighting and smart waste projects), and other environmental programmes.
- **Community Reach:** Assesses the engagement across multiple communities, the involvement of local businesses and academic communities in smart city projects, and the extension of projects into the wider city region and other local agencies.

3.4 The Index Rankings

Navigant Research scored the cities in the UK Smart Cities Index according to four categories: Leaders, Contenders, Challengers, and Followers. These categories are defined below.

3.4.1 Leaders

Leaders are cities that scored 75 or above in both Strategy and Execution. These cities have differentiated themselves through the clarity, breadth and inclusiveness of their smart city vision and planning. They are also leading the way in implementing significant projects at both the pilot and increasingly full-scale levels.

3.4.2 Contenders

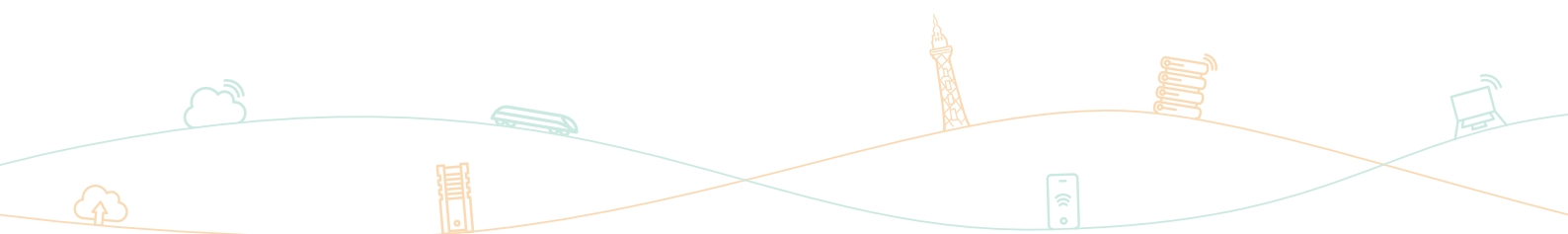
Contenders are cities that scored above 50 in both Strategy and Execution but are not yet Leaders. While these cities have done much to establish their smart city strategy and have implemented some significant projects, there are still some gaps in their strategy, and they have fewer projects than smart city Leaders.

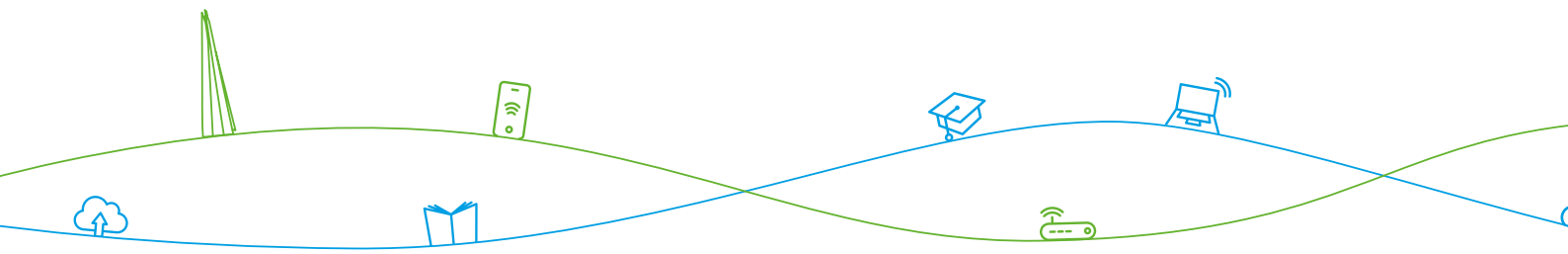
3.4.3 Challengers

Challengers are cities that scored higher than 25 in both Strategy and Execution but are not yet Contenders. While these cities have laid down a vision for their smart city endeavours and begun to deploy projects, execution still trails the vision outlined by a significant margin in some areas at least. They may have shown strong initiative in a few key areas but lack of broader overview.

3.4.4 Followers

Followers are cities that have initiated some smart city projects but have not yet established themselves as leading innovators or developed extensive smart city strategies. They score below 25 in either Strategy or Execution. These cities need to move beyond initial statements of intent, limited pilot projects and siloed operations to develop a more integrated view for city development and/or stronger leadership for their programmes. None of the top 10 cities are ranked as Followers in this Smart Cities Index. Information on some of the most interesting Follower cities is provided alongside our rating of the leading cities in section 5.4.





SECTION 4

SUMMARY OF THE ASSESSMENT

4.1 The UK Smart Cities Index

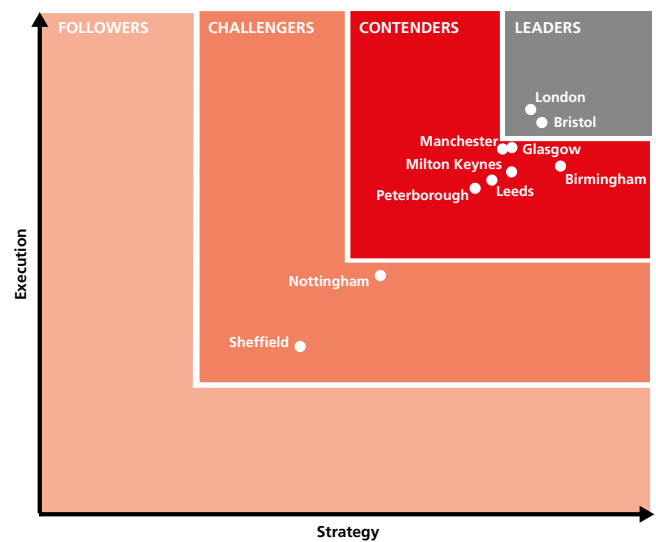
This study has revealed the strong commitment of UK cities to innovation and service improvement. All of the cities in the Smart Cities Index have developed significant programmes and their city leaders have high ambitions over the coming decade. They are setting out plans to use technology and service innovations to deliver more efficient services, to meet the needs of an ageing population, and to ensure that the city has the infrastructure and skills needed to be competitive in a global economy. In addition, they have established ambitious carbon reduction and resource management goals.

While the cities share many common themes and goals, each is developing its smart city capabilities in its own particular context that reflects local priorities, strengths and challenges. Size matters, but it does not in itself determine how smart a city might be. The cities in the report range from Peterborough, with a population of less than 200,000, to London with a population of more than 8 million. Some of the cities covered are growing rapidly and some are still dealing with post-industrial population decline. All are working within extremely challenging budgetary situations.

This is also a period of considerable change and uncertainty in the governance and function of UK cities. The major cities are in negotiation with the UK government around the devolution of greater powers and economic control, as well as changes in local governance with the introduction of elected mayors for city regions. The city evaluations in this report focus on the programmes instigated by the unitary authority but also reflect their engagement with the wider city area.

4.2 City Rankings

Chart 4.1 UK Smart Cities Index



(Source: Navigant Research)

4.2.1 The Leaders

Two cities are identified in the Navigant Research rankings as Leaders in the process of becoming smart cities: London and Bristol. These two cities are taking different routes that reflect different local circumstances, opportunities and challenges, however both are combining technical innovation with a broader strategy for their development.

- London is unique in its scale and its potential, but also faces the challenges of complex governance structures and a lack of consistency across its multiple authorities. The London Datastore and the capital's energy plans show how it can be a leader in technology and sustainability as it is in finance. The Mayor of London and the Greater London Authority (GLA) have a key role in maintaining a coherent and consistent framework for the development of the city as a whole in its climate plan, smart city goals as well as the broader London Infrastructure Plan.

- Bristol combines an ambitious city networking project with Bristol Is Open, an initiative which has the potential to be a world-leading environment for the testing of urban innovation, with an overarching city programme that also led to the city being named European Green Capital in 2015. The city is a leader in open data access, energy innovation and imaginative forms of community engagement.
- Leeds has set out ambitious plans to be the best city in the UK by 2030 and in particular wants to be the best city in which to grow old. Its work on the Leeds Data Mill and on joint social and health care projects, as well as digital inclusion for the elderly, are notable steps towards this goal.
- Peterborough is utilising technology platforms to support its smart city vision but has impressed most of all in its work with local communities in the development of its Circular City vision, which promotes re-use, energy efficiency, innovation and collaboration.

4.2.2 The Contenders

Behind the Leaders in the Index are a group of cities that are also developing strong smart city programmes and driving innovation in a number of areas.

- Birmingham has developed an extensive smart cities vision and strategy that it is marrying with its digital innovation programme. Its plans to make the East Birmingham area of the city a testbed both for technology and community engagement provide a strong basis for turning that vision into real city improvements.
- Glasgow now has the opportunity to build on the projects developed with support of the Future City Demonstrator award. It is identifying projects that it will take forward and is sharing ideas with other Scottish cities as part of the Smart Cities Scotland programme.
- Manchester has been investing in digital innovation for many years. The Manchester Corridor is becoming a site of focused innovation. The current EU-funded and energy-focused Triangulum project will soon be complemented by the UK government-funded IoT Demonstrator. The city's ambitious plans as a showcase for the devolution of city powers, which will lead to an elected mayor for the city region in 2017, also provide a distinct framework for its smart city programmes.
- Milton Keynes is establishing itself as a testbed for new urban technologies with its IoT projects and autonomous vehicle trials. Consciously designed as a laboratory for urban innovation, the onus is on the city to take the successes from MK:Smart and find the means to turn them into larger-scale projects. The development of the MK:Smart Data Hub is an investment that should provide wide-scale benefits to multiple projects across the city.

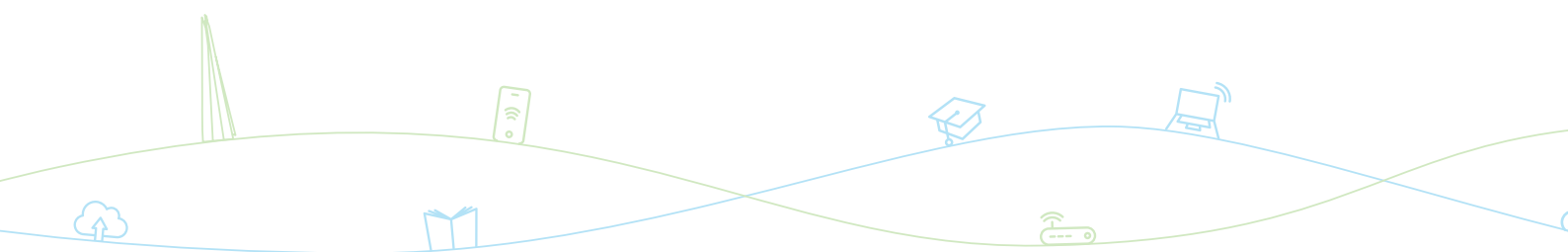
4.2.3 The Challengers

Nottingham and Sheffield have developed interesting approaches to smart city evolution, even if their programmes lack the breadth and cohesion of the leading cities.

- Nottingham has made the notable move of establishing its own energy company and has also been a leader in transport innovation. It has the opportunity to build on this foundation to develop a distinct vision for a UK smart city.
- Sheffield launched its smart city strategy in January 2015 and is still in the relatively early stages of fleshing out its projects, but the city has made some notable early steps such as the establishment of the Smart City Lab competition, but more needs to be done if it is to catch up to the leading cities.

4.2.4 The Followers

None of the top 10 cities in the Index fall into the Follower category. However, a number of UK cities that would fall into this category are developing smart city programmes and related projects. Some of the most interesting projects in Belfast, Brighton, Cambridge, Ipswich, Newcastle, Oxford, and Reading are highlighted in the Followers rating section, Section 5.4.



LONDON

5.1 Leaders

Summary

London has been a leader in a number of significant urban innovations, including the London Congestion Charge and other low-carbon transport programmes. It has an ambitious climate plan, an energy programme that emphasises local resources and the importance of retrofitting an ageing building stock and a strong commitment to open data and the exploitation of data to improve services. London's infrastructure investment, innovation culture and ability to attract investment are also important factors in its success. Many of these developments have been driven by the Mayor's office and the election of a new mayor in 2016 can be expected to add a new impetus to the city's smart city initiatives.

The biggest challenges for London are not surprisingly aspects of its size and complexity, notably ensuring that benefits of the smart city spread across all communities. A significant responsibility will fall on the boroughs, but there is also an important and continuing role for the GLA to provide direction, encourage collaboration and support the sharing of innovations.



**1 million more
people between
2011 and 2021**

Strategy

As a global megacity, London operates on a different scale than any other UK city. Moreover, London continues to grow rapidly and is expected to add another million people between 2011 and 2021. London also benefits as a centre for the finance industry, global technology companies and world-renowned universities. London's unique situation brings many advantages but also presents specific challenges in terms of infrastructure requirements, service delivery and governance models.

Responsibility for London's evolution toward a smart city is shared between the Mayor of London, the GLA and the 33 London boroughs. The promotion of a smart city strategy across London was given a boost in 2013 with the establishment of the Smart London Board and publication of the Smart London Plan. The chair of the Smart London Board is Professor David Gann from Imperial College London; the board has members from

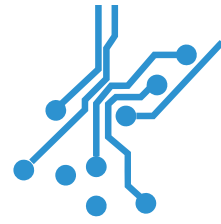
The Smart London Plan stresses the need to:



Drive technical innovation



Invest in education and training



Invest in the city's data infrastructure

the public sector, academia and leading technology suppliers. The Smart London Plan stresses the need to drive technical innovation through collaboration across London businesses and agencies and for investment in education, training and the city's digital infrastructure. The plan also encourages the further opening up of data resources and for greater sharing of ideas and insights across the London boroughs. A Digital Inclusion Strategy for London was published in January 2015.

Key Initiatives and Projects

London was an early proponent of the benefits of open data for urban innovation. The city took a strong lead with the establishment of the London Datastore and an extensive programme to encourage developers to use this data, with Transport for London being particularly notable for its collaboration with third parties. The GLA team is now driving the next stage in the use of open data, focusing on the quality and use of data and supporting the boroughs on data-driven projects. An example of the use of detailed data modelling is a neighbourhood demonstration project in the districts of Bromley-by-Bow and Poplar that is using 3D visualisation to help guide local decision-making across multiple developments, including community-owned infrastructure, home energy management systems, smart grids and building retrofits.

An important focus for the Smart London Plan is supporting innovation in the capital. So far, two Smart London Innovation Networks have been established. The Smart London Districts Network launched in 2014 brings together public and private development organisations that are delivering London's largest and most ambitious development districts. The Smart London Infrastructure Network includes organisations delivering London's infrastructure services, primarily the utilities responsible for water, energy, telecommunications and waste management. The city has also been promoting its role as a centre for the digital economy, notably with the rise of the Tech City cluster in Shoreditch.

London has a well-established commitment to reducing its carbon emissions. Its Low Carbon Capital strategy set a target to reduce carbon emissions by 60% by 2025 against 1990 levels. This was reaffirmed in the Mayor's climate change mitigation and energy strategy, the final version of which was published in October 2011.

The city is currently engaged in several smart grid projects across the city, including the Dispower project, a smart urban low-voltage network, and the UK Power Network's Vulnerable Customer and Energy Efficiency Project. The GLA has also become the first local government authority in the UK to be licensed as a junior energy supplier. This enables the city to buy power from small generators at a higher price and sell it on to other public bodies at an attractive rate.

ITS LOW CARBON CAPITAL STRATEGY SET A TARGET TO REDUCE CARBON EMISSIONS BY 60% BY 2025.

London has also taken a lead on energy efficiency programmes for the public sector with the RE:FIT programme. RE:FIT enables public bodies to use a framework of pre-selected energy service companies to retrofit energy efficiency measures in buildings. The scheme is funded through a combination of London development funds, European Commission funds for energy efficiency and private sector investment. It provides a good example of London's ability to leverage its financial clout. To date, 202 London public sector organisations are participating in RE:FIT. The programme has so far retrofitted over 530 of London's public sector buildings, generating estimated CO2 savings of 30,300 tonnes per annum from an investment of £90 million.

There is an inevitable great diversity in approaches to smart city development across the London boroughs, with each borough focusing on its own priorities and possibilities. A few boroughs have taken a lead in developing their own smart city strategy, most notably the Royal Borough of Greenwich. Greenwich launched a new smart city strategy in October 2015, which is being led by the Digital Greenwich team. Greenwich aspires to be recognized as London's "smart" and innovative borough. Other notable programmes include Camden's Digital Camden strategy and a number of technology projects in Westminster, including the deployment of smart parking technologies.

London is the focus of two of the country's largest infrastructure projects, Crossrail and the HS2 rail link. The Old Oak and Royal Park development, where the two projects meet, presents an opportunity for sustainable development. The project management team is actively exploring new opportunities around digital infrastructure and information sharing. Queen Elizabeth Olympic Park is an established development that is the site of a series of significant sustainability and digital initiatives, including a local low-carbon energy network.

In January 2016, it was announced that London—along with Milan and Lisbon—had been awarded funding under the EU's Horizon 2020 programme for the 3-year Sharing Cities project to develop, deploy and integrate replicable solutions across the energy, transport, data and information and communications technologies (ICT) sectors. The aim of the demonstrator project is to explicitly test the replicability of these systems to deliver sustainable and intelligent solutions. The London demonstration area will be the Royal Borough of Greenwich. Around €25 million will be provided for the London demonstration projects, which will include energy efficiency, renewable energy, urban mobility and smart parking projects.

Figure 5.1 Queen Elizabeth Olympic Park



(Source: Greater London Authority)

BRISTOL

Summary

Bristol has established itself as a leader in many aspects of smart city development. The broader smart city strategy provides a framework to connect successful innovations with priority issues for the city and its communities. The Bristol Is Open project provides a basis for Bristol to develop as a unique laboratory for urban innovation. Bristol is also leading the way in areas such as open data access, energy innovation and community engagement. The encouragement of playable city ideas is also an important reminder of the need for smart cities to be attractive and engaging, as well as efficient and data rich.



**Approximately
442,000 inhabitants**

Strategy

Bristol is the largest urban area in South West England, with a population of approximately 442,000 inhabitants. Bristol is part of the West of England Local Enterprise Partnership, one of the richest in the UK, with a gross value added (GVA) per head of £26,820—the highest outside London. The area has one of the largest concentrations of microprocessor and network architects and strong local creative and digital media sectors. Despite its advantages, the city faces a number of challenges, including social inequality (with a 10-year difference in life expectancy across different parts of Bristol), congestion problems, housing issues and the need to improve employability and skills among its young people.

Bristol's smart city strategy is led by the Bristol Futures team and has strong backing from the city's elected mayor. Key elements of the smart city programme include the ambitious Bristol Is Open project and the Green Bristol plan, which led to the city winning the title of European Green Capital 2015. In transport, the city is part of the VIVALDI Urban transport programme, also supported by the European Commission.

The Bristol Is Open project is using:



Fibre in the ground



Wi-Fi wireless networks



Radio frequency mesh network based on city lampposts

Key Initiatives and Projects

Bristol Is Open is a joint venture between the city and the University of Bristol to develop a unique city-scale communications and data sharing platform. The team is developing an open high-speed network that will foster innovation across multiple city applications. The project is integrating three networks through software control with capability being released throughout 2016: fibre in the ground, a wireless het-net along the Brunel Mile area of Bristol with Wi-Fi, 3G, 4G, LTE and 5G experiments, and a radio frequency mesh network based on city lampposts. The networks are being extended from Bristol into the wider city region over the next couple of years, creating an open programmable region reaching as far as Bath, an area covering more than 1 million people. A core element of the project is the City Operating System (CityOS), developed by the University of Bristol's High Performance Networks research group. The CityOS can dynamically slice the network so experimenters get the connectivity and network they need. Using an SDN allows the project to integrate multiple networking technologies on a single management platform.

Open data access is a key element of Bristol Is Open and the city's wider smart city strategy. The city has opened up its own data as part of its open data strategy with a focus on mobility, energy, crime/security, environment and public safety. Bristol is encouraging businesses, entrepreneurs and academic institutions to leverage city data sets and new sensor data in order to help develop smart city products and services.

Another example of the city's focus on the opportunities offered by big data is the Bristol Data Dome. The Data Dome is the result of a major upgrade to the city's planetarium to create a stereo 3D hemispherical screen with 4K resolution. It is connected to a high performance computer at the University of Bristol via the fibre optic network. The Data Dome will be used for a range of public and private sector projects, including the use of data visualisation to support complex city planning and investment processes.

OPEN DATA ACCESS IS A KEY ELEMENT OF BRISTOL IS OPEN AND THE CITY'S WIDER SMART CITY STRATEGY.

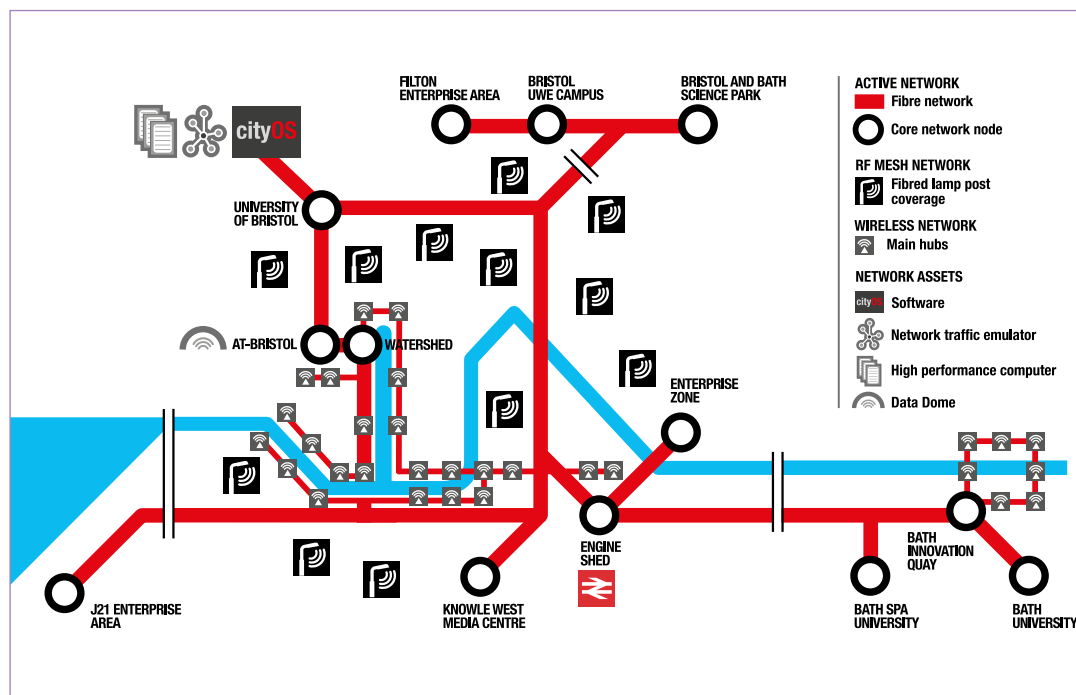
To promote the wider use of city data, the city has already instigated some hackathons, with more planned for 2016. It also collaborated with Watershed to create the Playable City event, which brought together artists and designers from the UK and beyond for a 5-day workshop in which people worked together to experiment and prototype playful interventions that use creative technologies to rethink public space. The concept has been embodied in a number of projects on the streets of the city. Bristol is also working with residents on the Citizen Sensor project, which aims to get residents involved in the design and use of monitoring devices in their community. The goal of the project is to increase the community's understanding of the data issues involved and to increase the transparency of the process.

In addition to its strong programmes for digital innovation, the city is rethinking other aspects of city operations. One of the most important projects is the Bristol Smart Energy City Collaboration. Approved by the city council in early 2015, a city-owned energy company will take responsibility for the smart use, distribution and supply of energy across Bristol, with a strong emphasis on resilience and carbon efficiency. The expected benefits of the new approach include the ability to access, manage and analyse local energy data and to co-ordinate city and community-scale interventions to balance demand and supply across the city. Currently in market testing, this initiative builds on a number of recent energy efficiency, renewable energy and smart grid pilots.

Bristol recognizes that it still has much to do in the area of transport strategy. Car ownership and car use in the city are among the highest in the country. The city has a far higher level of commuting than neighbouring areas, and transport in the region is predominately car-based, causing significant congestion problems. Among a number of initiatives to improve this situation, the city is using real-time data access on traffic conditions and transport services to help people make smarter travel decisions. It is also supporting the deployment of electric vehicle (EV) charging stations and is one of four cities in the UK chosen to host a trial of autonomous vehicles.

A number of Bristol’s pilot projects have been focused on the Knowle West regeneration area, but projects are now being expanded into other areas as well. The REPLICATE (REnaissance of PLaces with Innovative Citizenship And TEchnologies) project, for example, is located in East Bristol and is focused on creating smart city solutions to tackle urban problems such as traffic congestion, poor air quality and unsustainable energy use. This project is funded through the EU’s Horizon 2020: Smart Cities and Communities programme and involves the cities of San Sebastián and Florence.

Figure 5.2 Bristol Is Open: City Region Plan



(Source: Bristol Is Open)

BIRMINGHAM

5.2 Contenders

Summary

Birmingham has established an ambitious and detailed smart city strategy that encompasses a range of agencies, stakeholders and communities. The city has made good progress against its initial goals, but the main challenges lie ahead. It is now developing detailed plans for the development of innovative solutions in East Birmingham for projects that exploit the investments being made for the HS2 high-speed rail project, and for the establishment of a digital infrastructure and information sharing platform to support this and other projects. There is a clear opportunity for Birmingham to build on its initial digital innovations and link them with the city and regional development plan. The East Birmingham demonstrator will provide an interesting test of how these elements can be brought together to address a range of community issues. Already, new projects and activities relating to the IoT, big data, healthy ageing, geospatial regeneration and community engagement are beginning to emerge.



10% population increase expected by 2026

Strategy

The Metropolitan Borough of Birmingham is home to more than 1.1 million people and is the second largest city in the UK. Birmingham sits at the heart of the West Midlands, which is made up of seven metropolitan boroughs, including the cities of Coventry and Wolverhampton. As a growing city that is expected to increase in population by 10% by 2026, Birmingham faces challenges in providing infrastructure and housing. Another key challenge is the need to develop local skills to meet the requirements of the city's new and developing businesses.

The Birmingham Smart City Commission was created by the Birmingham City Council in July 2012 and involved representatives from business, academia and the public sector. The commission was responsible for developing the initial smart city roadmap for the city, which was then refined through a process of consultation with other stakeholders. The Birmingham Smart City Alliance brings together a number of stakeholders involved in the smart city strategy to align the groups and maintain continuity.

Birmingham's smart city Roadmap has three core themes:



Technology and Place



People



Economy

Digital Birmingham is the council's organisation responsible for coordinating the commission and overall progress against the city's smart city roadmap, working with the various city delivery agencies and partners. There is a strong digital component in the smart city strategy and roadmap, including goals related to connectivity, developing the digital infrastructure, digital inclusion and the creation of information marketplaces.

Key Initiatives and Projects

Birmingham's smart city ambition is to become "the agile city where enterprise and social collaboration thrive – helping people to live, learn and work better by using leading technology." Its smart city roadmap has three core themes:

- Technology and Place—spanning connectivity, planning for digital infrastructure and information marketplaces
- People—covering digital inclusion, skills and employment and innovation
- Economy—including health, well-being, and care; ICT; energy efficiency; and mobility

Seven priority areas for action have been identified, covering leadership, technology, service transformation, innovation, information marketplaces, digital inclusion and attracting investment.

Current and planned projects in Birmingham span most aspects of city operations. The city has been investing in its digital and data infrastructure. Public Wi-Fi is available across the city following a project between Birmingham City Council and Virgin Media Business; Wi-Fi has also been installed in over 200 public buildings.

The Birmingham Data Factory is a platform for accessing the city's open data sets. Data is currently available from the city council (which has an open-by-default policy), Centro (the West Midlands transport providers), and other agencies. The plan is for the Data Factory to become an information marketplace for use by diverse data providers. The West Midlands Open Data Forum brings together data experts, enthusiasts and developers from across a number of sectors that are actively using the data available. Birmingham has now established an Open Data Node within the city in order to accelerate the exploitation and value of data.

THE CITY HAS BEEN INVESTING IN ITS DIGITAL AND DATA INFRASTRUCTURE.

One of the most ambitious programmes in the city is the East Birmingham Smart City Demonstrator, where various smart city concepts and technologies will be developed relating to mobility, health, skills, enterprise development and information marketplaces. This builds on the initial smart city roadmap and will have a strong focus on outcomes that have an impact on the local community rather than technology pilots. The aim is to actively involve the local community in the design of projects and in decisions as to what data is collected and how it is used.

Birmingham also has a well-defined sustainability strategy led by the city council's Green Commission. The city's carbon target is a 60% reduction in total emissions by 2027 and 80% by 2050 from 1990 levels. The Green Commission's roadmap contains various actions to help the city achieve these and other goals around the themes of green growth, behaviour change, energy efficiency, energy resources, mobility and climate adaptation. A number of energy and sustainability projects have already been implemented. The existing Birmingham District Energy Scheme is being extended through the city centre, and plans for a city energy services company have been accepted by the city council and are in the detailed specification stages.

The city is working with local universities on many of its smart city projects, including a number of incubator projects such as the Energy Research Accelerator, which includes a number of universities in the West Midlands and the national Energy Systems Catapult, which will be located in Birmingham from 2016. The Serendip Incubator is a new environment in the city's Knowledge Quarter that will go live in 2016 to support digital startups addressing opportunities in the areas of digital health, mobility, IoT and smart cities. The city has also attracted the attention of the other Catapults, with activities also being developed with the Transport, Digital and Future Cities Catapults.

Figure 5.3 Birmingham Smart City Vision



(Source: Birmingham City Council)

GLASGOW

Summary

Glasgow's Future Cities Demonstrator has given it a unique platform on which to build its smart city strategy. The challenge now is to ensure that momentum is maintained on the most successful projects and the spirit of innovation is retained. The city is already working on a plan for future developments. It will also be publishing a report on lessons learnt in the past 2 years. Its role as lead partner in the Scottish Smart Cities Alliance provides another avenue to build on the experience of the last 2 years.



**Approximately 600,000
inhabitants**

Strategy

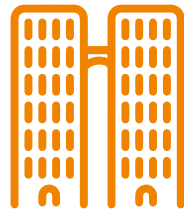
Glasgow is the largest urban area in Scotland, with a population of approximately 600,000 inhabitants in the city core and of 1,200,000 including its suburbs. Historically, the city has been the centre of industry in the country. Glasgow also plays an important role in the development strategies of Western Scotland. Glasgow continues to see a decline in its population, presenting different challenges to some of its fast-growing counterparts in the UK. Social and health services for the elderly and digital inclusion are high on the agenda as the city attempts to improve life expectancy and address social exclusion.

Glasgow's smart city ambitions received a significant boost when it was awarded the £24 million Future City Demonstrator grant in 2013. The award has been used to fund a series of projects across the city that aim to improve the lives of Glasgow citizens and to establish the city as a centre of urban innovation. The 2-year programme was completed at the end of 2015, and a final report is being prepared alongside a plan for building on its successes as part of the city's development strategy. Glasgow's smart city experience is also a key element in the development of the Scottish Smart Cities programme, which spans Scotland's seven cities.

The Future City Demonstrator programme involves projects covering:



Data and Energy



Building Innovations



Lighting

Key Initiatives and Projects

The Future City Demonstrator has been the main programme for smart city innovation in Glasgow, with projects covering data, energy, building innovations and lighting. Digital Glasgow has been established to improve the city's broadband infrastructure, wireless Internet access, digital participation and skills as well as digital public services. It is also working with SMEs and ecommerce providers to drive innovation and help develop new digital businesses; data sharing is a key part of the strategy. Open Glasgow is the platform developed to share public sector data sets from the city council and other organisations and to provide a gateway to the City Dashboard, an online, personalized dashboard that presents real-time data to citizens. In addition, the Data Launchpad provides a platform for multiple organisations to share data that can help provide insight into the city. Trusted partners can manage their own open data and have access to a suite of tools including machine learning and real-time data analytics applications.

The city is working with the Wheatley Group in two pilot projects to provide low-cost broadband to its social housing tenants. The first pilot includes 12 homes with 12 different solutions in low-rise properties, and the second is a multi-storey block with 138 units. The city is also running a Digital Apprentices programme to increase the digital skills of young people starting their careers. Finally, the city has set up 33 learning centres equipped with 630 PCs to offer courses to improve adults' employability through digital skills and has launched a Silver Surfers programme for the elderly.

A key development has been the new Glasgow Operations Centre, a state-of-the-art integrated traffic and public safety management system. The new centre brings together public space CCTV, security for the city council's museums and art galleries, traffic management and police intelligence.

The city has several significant energy and sustainability projects underway. The Glasgow City Energy Model maps in 2D & 3D the energy consumption of residents and businesses across Glasgow and can also map renewable generation. A gamified engagement tool has also been designed to encourage people to modify their energy behaviours. The city also has several building energy management projects, including pilots that use sensor technologies for building monitoring and the use of demand-side management for city council properties. A smart street lighting pilot has also been deployed to test energy efficiency and has also been used to support other applications such as monitoring air and noise pollution levels.

A KEY DEVELOPMENT HAS BEEN THE NEW GLASGOW OPERATIONS CENTRE, A STATE-OF-THE-ART INTEGRATED TRAFFIC AND PUBLIC SAFETY MANAGEMENT SYSTEM.

Glasgow has also laid out a detailed transport plan in its Strathclyde Regional Transport Strategy (2014-2017) and its City Centre Transport Strategy reports.

In addition to infrastructure improvements such as subway modernisation, the strategy also highlights the role of smart and integrated ticketing, the use of smartphone applications for better fleet management, and new software to allow real-time scheduling, vehicle tracking, routing and management reporting.

MANCHESTER

Summary

Manchester's smart city strategy is building on its established digital strategy, a number of substantial demonstrator projects and its ambitions for regional devolution. It is implementing this through a number of key partnerships, notably with local universities, other local authorities across Greater Manchester and with private sector partners such as Siemens. The recently awarded IoT Demonstrator project gives the city a chance to further enhance its position as a pathfinder in the use of new urban technologies as well as new forms of local governance.



Strategy

The city of Manchester, with a population of over 520,000, is located at the heart of Greater Manchester, which includes 10 local authorities and the city of Salford and has a total population of around 2.7 million. The Greater Manchester region has the second largest economy in the United Kingdom after London.

Manchester is a central player in the emergence of the Northern Powerhouse, which aims to devolve more power to cities and close the economic divide between the North and South of Britain. As part of the new deal between the central government and the city region, the election of a mayor for Greater Manchester in 2017 will bring more devolution and fiscal power to the region.

Manchester needs to develop its infrastructure and services to support a population that is growing at an annual rate of 1.6%. The city also needs to address a range of social issues, including high levels of child poverty, unemployment and low life expectancy compared to other regions. The two key goals for the city's strategy are growth in infrastructure and science and reform of support for young people, troubled families and health and social well-being. The city's vision is that, "by 2025 Manchester will be among the top 20 smart cities in the world."



520,000
population

Manchester CityVerve team projects will focus on:



Healthcare



Transport



Energy and Environment



Culture and Community

Manchester's smart city strategy has evolved out of its long-standing digital strategy, which was coordinated by the Manchester Digital Development Agency, an initiative of the Manchester City Council. The digital strategy now falls under the Manchester Smart City programme, which has the six themes aimed at delivering better outcomes for the city and its citizens: Live, Work, Play, Move, Learn and Organise. Each smart city project has a bias towards one or two of these areas and should link to each of the others in some way.

The other foundation for Manchester's smart city programme was laid by its bid for the UK Future City Demonstrator award in 2012. Although unsuccessful in that bid, Manchester has since been successful with a number of other high profile projects, including two European Commission-led projects: the EU-China Smart Cities Forum and Triangulum. In November 2015, the CityVerve consortium was awarded £10 million as the winner of the Innovate UK IoT Demonstrator competition.

Key Initiatives and Projects

Many of Manchester's smart city projects, including Triangulum and the IoT Demonstrator, are concentrated in Corridor Manchester, a 243-hectare area stretching from St. Peter's Square to Whitworth Park that is fast becoming an R&D hub and includes cultural venues, a science park and development projects.

Triangulum is a 5-year, €25 million Horizon 2020 project involving Manchester; Eindhoven, the Netherlands; and Stavanger, Norway. The aim of the project is to examine the impact of a number of smart solutions for low-carbon development, including reduced energy consumption in buildings, increased use of renewable energy, increased utilisation of EVs, deployment of intelligent energy management technologies and the deployment of an adaptive and dynamic ICT data hub.

THE MANCHESTER SMART CITY PROGRAMME HAS SIX THEMES: LIVE, WORK, PLAY, MOVE, LEARN AND ORGANISE.

In December 2015, the Manchester CityVerve team was awarded £10 million to implement an IoT Demonstrator project. The aim of the project is to demonstrate the capabilities of IoT applications at scale across a city region. The CityVerve consortium is led by Greater Manchester Local Enterprise Partnership and the Manchester City Council. The projects will focus on four key areas: healthcare, transport, energy and environment, and culture and community. The project will make smart improvements to city infrastructure and services and will include community wellness initiatives, air quality monitoring, a bike sharing scheme and smart street lighting.

Manchester Open Data is the city council's website providing access to key city data sets. DataGM provides an aggregation of open data from local authorities and other public sector agencies across the region. In addition, Open Data Manchester is a voluntary, collaborative endeavour to encourage and support access to data relevant to the Manchester region. The programme works with all 10 Greater Manchester authorities as well as Transport for Greater Manchester and other data owners.

Manchester's environmental targets are set out in the Manchester: A Certain Future report, which defines the city's Climate Change Action Plan for 2010-2020. Targets have been set to reduce CO2 emissions by 41% by 2019/2020 against a 2009/10 baseline. Projects identified in the plan include a Civic Quarter Heat Network; greener public transport, cycle networks and EV charging infrastructure; green and blue infrastructure; and sustainable consumption and production of food and waste. Manchester is behind on meeting its carbon reduction goals according to the last review; however, progress is being made on the development of a local energy company and the extension of the city's heat networks.

Figure 5.4 Corridor Manchester



(Source: Corridor Manchester)

MILTON KEYNES

Summary

Milton Keynes was one of the first UK cities to make a strong commitment to develop and promote smart city technology. It is now establishing itself as a primary location to trial and test new city technologies and is successfully attracting investment from IoT companies and other innovators looking to exploit this emerging market. The close collaboration between Milton Keynes Council and The Open University is another important element in the programme, enabling the testing of emerging technologies and the rigorous assessment of realised benefits. The future challenge is to exploit the most successful solutions on a wider scale and to link even more closely the innovations of MK:Smart with the developing long-term strategy for the city.



**Population has grown
from 60,000 to 260,000**

Strategy

Since its designation as a New Town in 1967, Milton Keynes' population has grown from 60,000 to 260,000, and the city has the strongest 30-year growth rate in jobs and output of any UK city economy. Milton Keynes has embraced technology as an opportunity to address the challenges that it will face as a result of a growing population and as a route to deliver efficiencies and innovation in public services. Core objectives for its smart city programme include the improving services, expanding employment opportunities, reducing carbon emissions, and building leadership in urban innovation.

In September 2015, the Milton Keynes Council passed a resolution to set up the MK Futures 2050 Commission, a 9-month project that is tasked with developing a view of the long-term future for the city and making recommendations for long-term council policy. This will feed into Plan:MK, another council-driven process to develop strategic development options for the local area.

Milton Keynes' development as a smart city is being spearheaded by the MK:Smart programme, which was set up to develop innovative solutions to support economic growth in the city. MK:Smart is a collaborative initiative partly funded by HEFCE (the Higher Education Funding

The MK Data Hub provides data about:



Energy
and water
consumption



Transport



Satellite
technology



Social and
economic
data sets

Council for England) and led by The Open University, the Milton Keynes Council and BT, which are working with a number of technology partners including Huawei, Samsung and Tech Mahindra.

Key Initiatives and Projects

Milton Keynes is one of the first urban regions to implement a network based on IoT technology. In 2013, a consortium of infrastructure providers, SMEs and government-backed innovation centres established the UK's first citywide low-power wireless access network. Recycling bins and parking spaces were among the first things to be connected to the internet, and the deployment of sensors is now being extended to include initiatives such as people presence and soil moisture in parks. Sensors are also being used to monitor transport, energy, waste collection and water systems as part of the demonstration projects.

The MK Data Hub provides the data infrastructure for the MK:Smart project as a whole, supporting the collection, integration and use of data across multiple applications. This includes data about energy and water consumption, transport, satellite technology, social and economic data sets and crowdsourced data from social media or specialised apps. It is envisioned that the Data Hub will eventually become an information marketplace for the city used by a wide range of data providers that can take advantage of the ability to set privacy and policy conditions for any shared data.

Transport and urban mobility are focus areas for innovation in the city. The MK:Smart transport strand is promoting the concept of Cloud-Enabled Mobility. This project aims to connect users with real-time data to enable informed local travel decisions. The information is being made available to the public via a new citywide app, known as MotionMap, using data from a variety of sources. A driver behaviour app is also being deployed to collect a range of data, including traffic flows and road surface conditions.

Milton Keynes is one of four cities in the United Kingdom chosen to pilot autonomous cars. The testing of autonomous pod vehicles is scheduled to begin in 2016, with prototype vehicles first shown in September 2015. Initially, three vehicles will be used to ferry people from the city's railway station to the central shopping area on existing pedestrian walkways. The fleet will eventually involve up to 40 vehicles. A wider project with Jaguar Land Rover, Ford and Tata involves the testing of assistive and autonomous saloon car technology on the city's roads and how driverless cars might integrate with the other transport systems.

MILTON KEYNES IS ONE OF FOUR CITIES IN THE UNITED KINGDOM CHOSEN TO PILOT AUTONOMOUS CARS.

MK:Smart is also looking at ways to improve energy efficiency in the city. An Open Energy Map is being built to better understand local energy trends, supported by a partnership with energy provider E.ON. There are also pilot projects for the use of digital tools to support consumer demand shifts and the use of smart grid technologies for the better management of overall energy consumption during peak demand periods.

An integrated programme of business engagement aims both to ensure business take-up of the innovation capabilities developed in MK:Smart and to foster the development of new SMEs. A recently opened Innovation Centre is designed to integrate training and support for data-driven business innovation and the digital economy. It will provide hands-on support for business development at the point of need, as well as virtual and physical demonstration facilities and an incubation space.

Figure 5.5 Milton Keynes Smart Cars



(Source: MK:Smart)

LEEDS

Summary

Leeds has established itself as one of the cities driving smart city development in the UK. Its strategy for the city's development until 2030 sets a coherent and ambitious framework for its smart city projects, in particular its open data strategy. As with many cities, the challenge is to find the means to scale up its most successful projects and to encourage continued innovation in a wider range of services. Leeds was one of the shortlisted cities for the IoT Demonstrator award, which it was hoping would boost several of its digital innovation projects. It now has to find alternative approaches to ensure it stays in the leading group for smart city innovation.



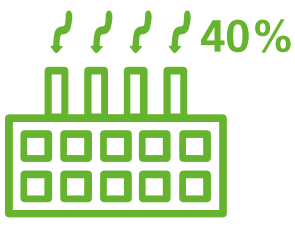
**Approximately
775,000 inhabitants**

Strategy

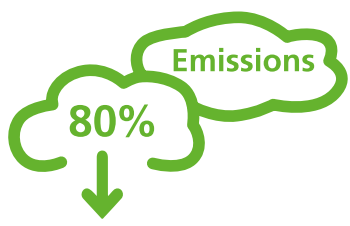
Leeds is at the heart of one of the UK's largest metropolitan regions. It is the second largest unitary council in the country, covering a population of around 775,000. It sits at the heart of the Leeds City Region, encompassing 3 million people across West Yorkshire. Leeds faces the challenge of providing services to a growing population with reduced resources but is driving forward with significant programmes to both improve services and bring new talent and investment into the city.

Leeds City Council has outlined an ambitious strategy to be the best city and best council in the UK by 2030. The strategy embraces all aspects of city operations as well as ambitious environmental goals. Leeds has also made a notable commitment to being the best place in the UK to grow old in, which it is supporting through a range of initiatives in its Better Lives programme. Developing smart city capabilities is part of these broader objectives. Leeds has placed a particular emphasis on the development of open data services and new approaches to urban analytics.

The Leeds Climate Change Strategy has set targets to:



Reduce greenhouse gas emissions in Leeds by 40% by 2020-2021



Reduce total emissions by 80% between 2005-2050



Recycle 60% of city waste

Key Initiatives and Projects

Leeds has put a strong focus on the use of open data and data analytics to support urban innovation. The Leeds Data Mill was one of the first platforms in the United Kingdom to bring together open data information from multiple sectors and to enable that data to be accessed for analysis and to develop new service solutions. The Leeds Data Mill is part of a number of data-focused initiatives in the city, including the Leeds Institute for Data Analytics at the University of Leeds and the work of Connecting for Health, an organisation responsible for maintaining and developing the NHS national IT infrastructure.

An example of the data projects that Leeds is nurturing is the Ripple community, an open source demonstrator for integrated care records funded by the NHS Technology Fund and hosted by the Leeds City Council. Leeds has also been looking to use technology to deliver on its social care policy. In addition to supporting telehealth projects, the city has launched a digital inclusion project aimed at the elderly. The Age Friendly Leeds Smart City projects are piloting a range of approaches to expanding access and developing service co-creation models with residents.

The city has also been investing in its communications infrastructure, with free Wi-Fi now available in over 200 public buildings. Leeds had more businesses gaining access to fast broadband through the SuperConnected Cities schemes than any other city outside London.

The Leeds Climate Change Strategy has set a target of reducing greenhouse gas emissions in the city by 40% by 2020-2021 against 2008-2009 figures. It has also committed to reduce total emissions by 80% between 2005 and 2050. Other key environmental targets are for 60% of city waste to be recycled; over 40% of the city's waste was recycled in 2015, the best performance among the largest UK cities. Leeds SmartKlub is a project led by Leeds City Council and the SmartKlub initiative to establish a collaborative environment for businesses looking to reduce their energy consumption and carbon footprint.

LEEDS HAD MORE BUSINESSES GAINING ACCESS TO FAST BROADBAND THROUGH THE SUPERCONNECTED CITIES SCHEMES THAN ANY OTHER CITY OUTSIDE LONDON.

PETERBOROUGH

Summary

Since its inception, the smart city programme in Peterborough has focused on producing benefits for the community and small businesses rather than simply trialling the latest technology. Encouraging local involvement and collaboration from both citizens and business entities is a recurring theme.

Peterborough's initial strategy paper laid a strong foundation for its smart city programme with a comprehensive view of future goals and key projects. In general, it is taking a pragmatic approach to identifying projects with a strong community base and has prioritised delivering practical benefits over purely technology-focused pilots. The city has also established a realistic approach to funding and has made good use of its Future Cities award. Its success and its innovative approach to the circular economy were acknowledged internationally at the end of 2015 when it won the Smart City of the Year award at the Smart City Expo World Congress in Barcelona.



**Approximately
190,000 inhabitants**

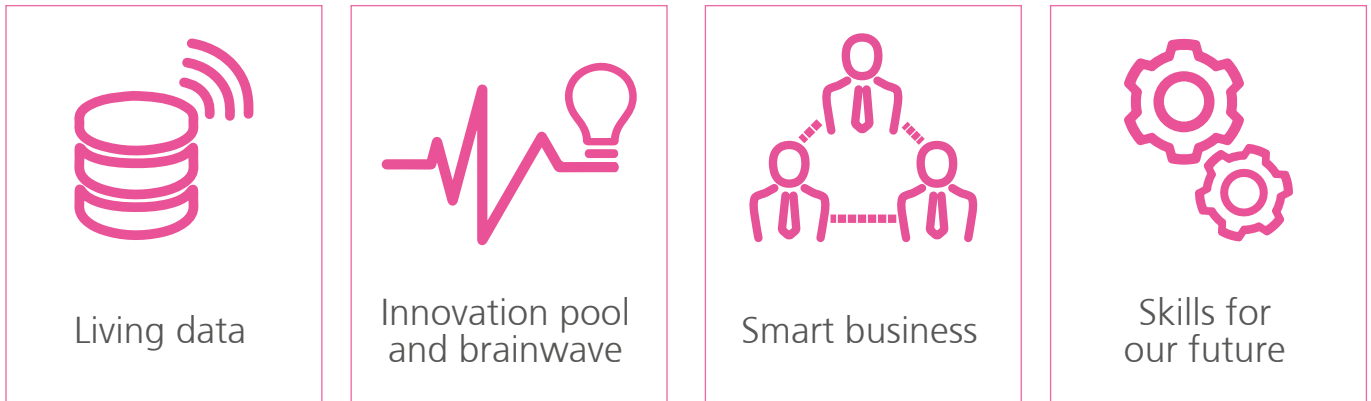
Strategy

Although it is the smallest city covered in the Smart Cities Index, Peterborough is one of the fastest growing cities in the UK, with a current population of about 190,000 and a wider catchment area of more than 950,000.

Smart city solutions are viewed as a key element in an integrated approach to addressing Peterborough's challenges, and the city's aim to establish itself as the UK's Environment Capital. There is close collaboration between the smart city, economic, and environment programmes, including shared leadership. Notably, Peterborough is developing a distinct focus on the circular economy with its detailed vision of the future Circular City.

In 2012, Peterborough was awarded £3 million by Innovate UK under its Future Cities Demonstrator competition.

The Peterborough DNA programme focuses on four key strands of activity:



The resulting programme, Peterborough DNA, has been jointly led by the city council and its economic development company, Opportunity Peterborough. This has fuelled further development and thinking on its smart and future city approaches. The programme focuses on four key strands of activity:

- Living Data: a live data resource as a platform for all activities and a source of public information
- Innovation Pool & Brainwave: a hub for business innovation
- Smart Business: a programme of demonstrator projects and business collaboration
- Skills for Our Future: to support the development of the individual skills and aspiration needed for the future city

Each of these strands is expected to have multiple activities within it that also link across to other initiatives. The city has also instituted a Smart City Leadership Programme to drive and monitor its progress toward its smart city goals.

Key Initiatives and Projects

Peterborough has adopted a strong focus on standards using both BSI and international smart city standards and is one of the original cities—along with London, Bristol, Glasgow, and Birmingham—involved in the Cities Standard Institute (CSI) initiated by the Future Cities Catapult and BSI. It is also an active member of the European Innovation Partnership on Smart Cities and Communities.

Fibre optic investment started in April 2014 to provide businesses and schools with improved high-speed internet connections. Peterborough has now built a 95-km optical fibre network across the city allowing businesses gigabit speed connectivity. An upgrade to LED street lighting with remote control began in August 2012, and transmitters situated on the lampposts enable free Wi-Fi access across the city centre.

Smart Fengate is a demonstration project in one of Peterborough's business areas. Funding has been available to support businesses to help them collaborate and to market test products, technologies, and services. What started as an experiment in a small business district has now grown into a broader strategy for the Circular City that emphasises collaboration and sustainability through maximising resources. A core group of 12 business members has been expanded into a wide network of more than 100 participants proactively collaborating and sharing experiences and challenges. An online platform, Share Peterborough, is under development that will enable a community of businesses to exchange goods, services, property, and skills.

Peterborough lacks its own university, but its University Centre plays an active role in delivering smart city projects. The city is also collaborating proactively with research institutions and academia outside the city to develop connections with local public, private and third sector bodies. It has been involved in projects and funding bids with a number of institutions including Cranfield University UCL, the Institute for Manufacturing at Cambridge University, and Anglia Ruskin University. Attracting graduates to Peterborough is seen as an important goal for its continued growth as a smart city. To address this, the Peterborough Graduate Scheme was piloted in 2015, enabling local businesses to employ a graduate for 6 months to tackle business and environmental sustainability challenges.

The city has also shown innovation in engaging the local community in smart city projects. The Brainwave Innovation Portal has been started to help companies and residents to work together on solutions to business, city, and community challenges. Smart Suppers involves local young people (12 to 18 years old) in city challenges and helps them to develop their business skills. Over 40 children have been involved, with some of the winning ideas now in development—from smartphone apps to green space development with recycled materials. The scheme won a Gold Green Apple Award for Environmental Best Practice in 2015.

NOTTINGHAM

5.3 Challengers

Summary

A core element of Nottingham City Council's strategy has been to maintain public ownership and control of infrastructure and assets. It has already had success with its city-owned energy company, public transport innovations and social housing programmes. Nottingham can build on this foundation and its EU-funded pilot projects to develop a distinct vision for a UK smart city based on energy and transport innovation. However, it would be good to see a more coherent vision for how these initiatives come together in an overall smart city plan. It will also be interesting to see how Nottingham's approach is able to support development from demonstration projects to wider deployments.



Approximately 314,000 inhabitants

Strategy

Nottingham has a city population of around 314,000 and is at the heart of a city region of nearly 756,000. City leadership has placed a strong emphasis on energy and transport policy, and is also focused on making Nottingham one of Europe's leading cities for science and innovation. Nottingham's focus on energy and transport innovation is particularly notable.

Energy sustainability has been a priority for Nottingham City Council since it published a 10-year Action Plan strategy in April 2010. This Action Plan included generating more local energy via solar PV and biomass combined heat and power (CHP) systems, as well as through cutting demand. Nottingham now claims it is both the most energy self-sufficient and least car-dependent city in the country. The Nottingham City Council has direct control over much of the city's infrastructure, transport and housing stock, which it believes is an important factor in being able to deliver a smart city in practice.

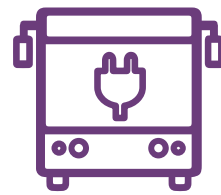
Transport innovation is a focus for Nottingham, which includes:



A smart ticketing system



Tram system linked to the power network



Fleet of 50 electric buses

Key Initiatives and Projects

Nottingham is a Department of Energy & Climate Change (DECC) Low Carbon Pioneer City and in 2012 was awarded £600,000 of feasibility and technical study funding for its energy programme. It also received £5 million of funding from the EU's Horizon 2020 research and innovation programme as a lighthouse city for the Remourban project to tackle sustainability issues concerning transport, energy, and ICT. Launched in 2015, the Remourban project is a collaboration between Nottingham City Council, Nottingham Trent University, Nottingham City Homes and Nottingham Energy Partnership in addition to two SMEs, INFOHUB and SASIE. The city council is also part of the EU InSMART (Integrative Smart City Planning) project in collaboration with the University of Nottingham.

Nottingham has strong ambitions to be a smart energy city. As laid out in its Energy Strategy 2010-2020 report, the city aims to deliver 20% of its energy from renewable sources by 2020. The plan also states that carbon emissions will be reduced by 26% by 2020 compared to 2025. An extensive district heating system, the 100% council-owned Enviroenergy, provides heating to 4,500 domestic and 150 commercial clients via high-pressure steam from a waste incineration plant.

The Nottingham City Council has chosen to retain ownership of a large quantity of its social housing and has set up its own local energy company. It has installed 2,700 solar panels on social housing properties across the city as well as a community micro power plant and a new CHP system for the Nottingham City Hospital. A Future Cities Smart Energy Home project, providing energy monitoring linked to a carer/relative alert facility, is being planned along with a low-energy street lighting replacement plan with integrated 4G broadband. In 2015, the city launched a new city-owned energy company, RobinHoodenergy, to deliver low-cost energy to city households and businesses.

Transport innovation is another focus for the city and has been closely linked to Nottingham's energy and carbon reduction strategy. A smart ticketing system is in operation for the public transport network, including a growing tram system that is 80% council-owned. The trams are linked to the power network and deliver regenerative braking energy back to the local grid. Transport options also include an electric car hourly rental scheme (City Car Club Nottingham) and a fleet of 50 electric buses with smart charging. A new option under development is a last-mile delivery hub, in which eight EVs will deliver on behalf of hauliers to minimize the number of trucks entering the city.

TRANSPORT INNOVATION IS ANOTHER FOCUS FOR THE CITY AND HAS BEEN CLOSELY LINKED TO NOTTINGHAM'S ENERGY AND CARBON REDUCTION STRATEGY.

The city has also been working on the development of its open data strategy. There are two platforms, the city council's own open data site and Nottingham Insight—the latter of which includes a wide range of data and information from the public sector across Nottinghamshire.

SHEFFIELD

Summary

Sheffield has made a start with the establishment of an initial vision for its evolution into a smart city. The new Sheffield Plan outlines some of the digital and technical innovations needed to support a smart city vision but there is little detail currently available. There is an opportunity for the city to make stronger links between its broader strategy and the potential for smart city innovations, as is being explored in the Smart City Lab. There are also opportunities to build on open data and data analytics projects across the public sector. However, further progress will be hampered without clearer leadership and coordination across Sheffield's smart city activities.



Strategy

A city with a long history as an industrial centre, Sheffield today has a population of around 550,000. The Sheffield City Council acknowledges that its history of heavy manufacturing has led to a city with large variations in economic prosperity and a marked difference between the east and west of the city. Despite this inequality, Sheffield exhibits greater social cohesion than many other cities.

In February 2015, a report was published proposing how the smart (or future) city concept should be adopted in Sheffield. The report was commissioned by the Sheffield First Partnership under the auspices of the Sheffield Executive Board, a non-statutory body made up of leaders from across the public, private, voluntary, and community sectors in Sheffield that exists to provide leadership on issues of citywide significance. The report presented a framework to map smart city activity in Sheffield against a broad set of city functions. It encourages city leaders to think in terms of six broad themes: inclusion, leadership, innovation, collaboration, data and resilience.

In November 2015, the Sheffield City Council launched an initiative to develop a plan for the city that looks forward 15-20 years. The target is to have an Action Plan adopted in 2018. The initiative sets out the challenges and opportunities for Sheffield and proposes a vision for



Approximately 550,000 inhabitants

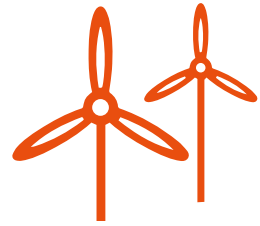
Sheffield aims to adopt an Action Plan to target much needed:



Improved transport



Housing



Sustainable energy

what the city will be like in 2034. It targets a growing population and the need for improved transport, housing and sustainable energy. Digital connectivity is seen as a key enabler along with education and training to develop the workforce. Contributing to the plan will be a grant of €203 million for the Sheffield City Region from the EU Investment Strategy awarded in 2014. This money will be used to support existing businesses, encourage the growth of new businesses and improve the skill levels of the local population.

Key Initiatives and Projects

Local service provider Amey and its parent company Ferrovial Services have worked with the city council to establish the Sheffield Smart Lab. The aim of the project is to establish Sheffield as a centre for urban innovation by identifying, developing and piloting new solutions to city challenges. The programme also aims to encourage and support entrepreneurs in Sheffield and to bring together expertise from Sheffield City Council, the University of Sheffield, Sheffield Hallam University and Amey/Ferrovial Services. The two initial challenges focused on rejuvenating activity and use of the city centre and supporting independent living for housebound adults. The winning submissions will be selected and pilots established in the first half of 2016.

The city has established an open data platform, currently host to around 100 city data sets. There are also efforts to improve the sharing of information across public sector organisations, notably through the establishment of a Centre for Big Data in Sheffield (C-BiDiS) to encourage data sharing arrangements between Sheffield's two NHS Trusts, two universities and the city council.

THE CITY HAS ESTABLISHED AN OPEN DATA PLATFORM, CURRENTLY HOST TO AROUND 100 CITY DATA SETS.

The city has established a Green Commission to develop and deliver its sustainability plan, but its sustainability strategy lacks clear targets at present. Sheffield has made significant investment in its mass transport network, with comprehensive bus and tram services, but recognizes that it needs to do more to address growing congestion and to reduce transport emissions. It is also home to one of the country's oldest district heating systems supplied by the city's Energy Recovery Facility for the processing of household waste.

FOLLOWERS

5.4 Followers

As well as the 10 cities evaluated in this report, a number of other UK cities are developing smart city plans and projects. Some of the most notable are outlined here.

5.4.1 Belfast

Belfast's smart city strategy is managed by Urban Evolution Smarter Belfast Collaborative Network, an ecosystem of public, private and academic organisations developed in order to position Belfast as a smart city. Through the network, Belfast shows the city's skills and economy with experience in key areas with knowledge, processes and innovative products to export. This group is at the planning stage, updating the strategy that Belfast presented for the TSB Future Cities board. Belfast won IBM's Smarter Cities Challenge in 2013 and, as a result, is being advised by experts from IBM until the end of 2016.

5.4.2 Brighton

Brighton has a strong focus on sustainability and digital innovation. It is one of three new Digital Catapult Centres that were launched in March 2015 (the others are in Bradford and Sunderland). The centre is led by the Coast to Capital LEP (Local Enterprise Partnership), which includes West Sussex, Lewes and Brighton & Hove, in collaboration with its core delivery partners, the University of Brighton and Wired Sussex. The centre will focus specifically on projects that encourage innovation and value from real-time and location-based data, referred to as the Internet of Place. The city is also the world's first designated One Planet City. The City Sustainability Action Plan received accreditation from sustainable development charity BioRegional in 2013. The plan covers an extensive series of actions and strategies for energy, waste, transport, water, and other aspects of city operations and services.

5.4.3 Cambridge

Smart City initiatives in Cambridge are being promoted by a special interest group within Cambridge Cleantech, an organisation formed of business, academia, voluntary and community groups with a cleantech agenda. One of the group's projects is Connecting Cambridgeshire, an initiative which is promoting a super-fast broadband network across Cambridge and Peterborough. Cambridgeshire Insight is an open data and shared research database for the county.

5.4.4 Ipswich

Smart Ipswich is a partnership of 17 leading businesses, universities and Suffolk local authorities that has taken the lead in promoting smart city projects in the region. The consortium is being led by the Suffolk County Council with support from the Ipswich Borough Council, Suffolk Coastal District Council, New Anglia LEP, BT, Huawei, Tech Mahindra and Proxama. The group's smart city plan was shortlisted as a contender for the IoT Demonstrator award that Manchester eventually won.

5.4.5 Newcastle

Newcastle was one of the first cities to sign a city deal with the previous government in 2012. This included the designation of Newcastle as a Low Carbon Pioneer City, which has driven a number of projects, including a district heating project. In January 2015, Newcastle University unveiled its £58 million investment plan for Science Central, which includes a state-of-the-art Urban Sciences Building. This aligns with the city's ambitions to make Newcastle a smart city of the future, with Science Central the flagship project bringing together academia, the public sector, communities, business and industry to create a global centre for urban innovation. Science Central officially opened in February 2016. The 24-acre Science Central compound is a long-term partnership between the Newcastle City Council and Newcastle University as part of the Newcastle Science City initiative. Initial projects include an EU-funded project on automated transport management.

5.4.6 Oxford

The Smart Oxford programme is being led by the Oxford Strategic Partnership, a group of collaborating organisations from across the public sector, academia, business, and voluntary and community groups. Projects under consideration include a common building energy platform to link energy data from domestic and residential properties; a super-fast broadband initiative called SuperConnected Oxford; an integrated public transport ecosystem called MobOX; and a renewable energy investment plan.

5.4.7 Reading

Reading's smart city strategy has been outlined in the Reading UK 2050 project. The city is promoting business incubation units called Ideas Factories, as well as the use of Reading University's city centre campus to exhibit and test innovative ideas and approaches. Other planned projects include retrofitting existing buildings and the development of iconic architecture to provide some of the greenest accommodation possible for incoming businesses. The city transport strategy includes plans for a Reading smart transport card; a comprehensive cycle network; and urban gondolas or a rapid transit system to connect the city from east to west, and north to south, relieving congestion in the town centre.

5.5 Summary of City Scores

Table 5.1 The UK Smart Cities Index Overall Scores

Rank	City	Score
1	London	80.5
2	Bristol	80.2
3	Birmingham	77.9
4	Glasgow	75.1
5	Manchester	74.2
6	Milton Keynes	72.5
7	Leeds	70.5
8	Peterborough	68.2
9	Nottingham	51.8
10	Sheffield	38.1

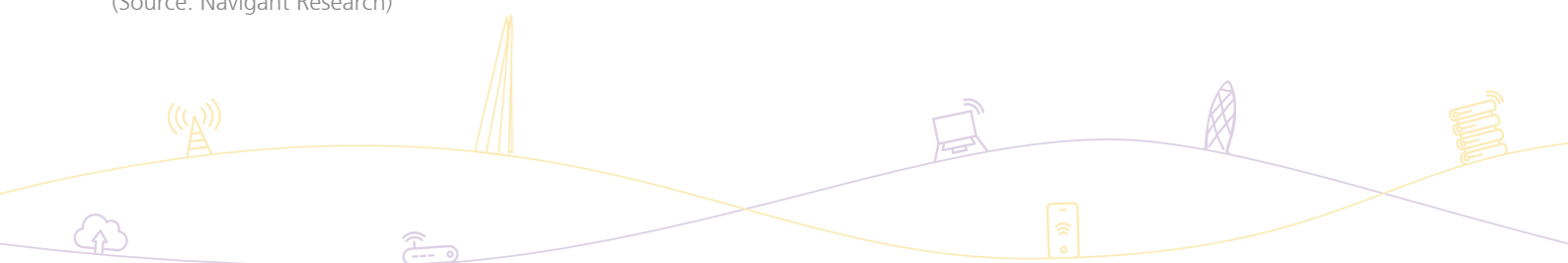
(Source: Navigant Research)

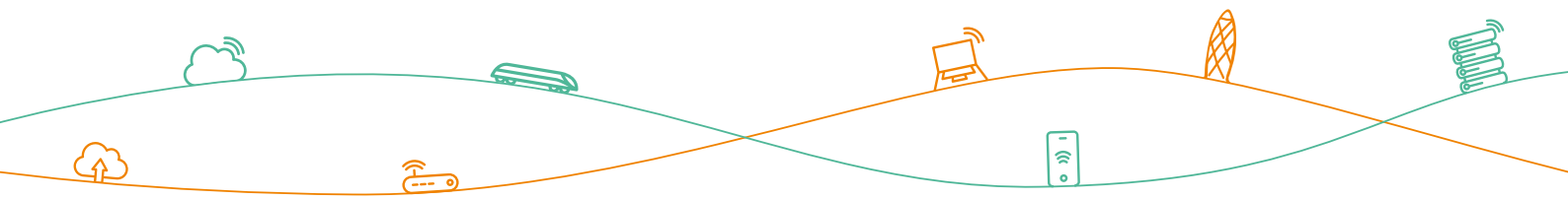
Figure 5.6 City Scores on Strategy and Execution Criteria

		Birmingham	Bristol	Glasgow	Leeds	London	Manchester	Milton Keynes	Nottingham	Peterborough	Sheffield
Strategy	Assigned Weight	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score
Smart City Vision	20%	92.0	84.0	76.0	70.0	78.0	68.0	78.0	50.0	76.0	28.0
Digital Innovation	30%	84.0	92.0	78.0	82.0	88.0	82.0	84.0	50.0	70.0	44.0
Service Innovation	30%	82.5	67.5	77.5	72.5	72.5	70.0	67.5	62.5	65.0	47.5
Sustainability Goals	10%	80.0	82.5	70.0	60.0	85.0	80.0	67.5	75.0	82.5	50.0
Stakeholder Engagement	10%	85.0	90.0	80.0	72.5	77.5	82.5	87.5	43.3	70.0	45.0
Total	100%	84.9	81.9	76.9	73.6	80.0	75.5	76.6	55.6	71.0	42.6

Execution	Assigned Weight	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score
Implementation	20%	70.0	85.0	80.0	65.0	80.0	75.0	75.0	60.0	75.0	20.0
Digital Delivery	30%	70.0	86.7	80.0	80.0	86.7	73.3	73.3	33.3	66.7	26.7
Service Delivery	30%	66.0	68.0	68.0	58.0	76.0	72.0	62.0	48.0	60.0	40.0
Environmental Impact	10%	67.5	70.0	55.0	55.0	75.0	67.5	60.0	72.5	70.0	47.5
Community Reach	10%	86.7	80.0	73.3	73.3	86.7	76.7	66.7	40.0	53.3	43.3
Total	100%	70.2	78.4	73.2	67.2	81.0	73.0	68.3	47.7	65.3	33.1

(Source: Navigant Research)





SECTION 6

SCOPE OF STUDY

Navigant Research has prepared this white paper to provide an independent analysis of the current development of smart cities in the UK. The report is intended for city leaders and managers responsible for smart city projects, government agencies and other bodies supporting cities, as well as suppliers seeking to better understand the smart city market.

The major objective of this Navigant Research white paper is to provide a timely assessment of the leading cities, including their strategy for smart city development and their execution against that strategy. Note that the city rankings capture the city's standing at the time of the report and are not a retrospective of past accomplishments or an indication of future success. The ratings are likely to change rapidly as cities accelerate their smart city plans and projects.

SOURCES AND METHODOLOGY

Navigant Research's industry analysts utilise a variety of research sources in preparing research reports. The key component of Navigant Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain including, but not limited to, technology companies, utilities and other service providers, industry associations, government agencies and the investment community.

Additional analysis includes secondary research conducted by Navigant Research's analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Navigant Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

Navigant Research is a market research group whose goal is to present an objective, unbiased view of market opportunities within its coverage areas. Navigant Research is not beholden to any special interests and is thus able to offer clear, actionable advice to help clients succeed in the industry, unfettered by technology hype, political agendas or emotional factors that are inherent in cleantech markets.

NOTES

CAGR refers to compound average annual growth rate, using the formula:
 $CAGR = (End\ Year\ Value \div Start\ Year\ Value)^{(1/steps)} - 1.$

CAGRs presented in the tables are for the entire timeframe in the title. Where data for fewer years are given, the CAGR is for the range presented. Where relevant, CAGRs for shorter timeframes may be given as well.

Figures are based on the best estimates available at the time of calculation. Annual revenues, shipments, and sales are based on end-of-year figures unless otherwise noted. All values are expressed in year 2016 U.S. dollars unless otherwise noted. Percentages may not add up to 100 due to rounding.

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