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Sally Caird with Lorraine Hudson and Gerd Kortuem   April 2016

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Report covers show Milton Keynes a smart new city, from the air. Image credits, with thanks © William Stephens

Foreword

It is with pleasure that I write the foreword for this insightful report '*A Tale of Evaluation and Reporting in UK Smart Cities*' on smart city practices in the cities of Birmingham, Bristol, Manchester, Milton Keynes and Peterborough.

The contemporary challenges of our growing population with associated urbanisation pressures set against a background of local and national budgetary constraints in the UK, means that city administrations must increasingly find novel, efficient, effective and economic approaches to governance. They must address the challenges of developing the infrastructures and services needed to help people live, work, travel and play - ensuring that cities can develop economically, whilst protecting the environment and quality of life for citizens.

Geoff Snelson, *Director of Strategy, Milton Keynes Council*

The emergence of the smart city and smart city thinking is a direct response to such challenges, as well as providing a means of integrating fast evolving technology into our living environment. Smart technologies offer cities exciting possibilities for new services provision and integrated city infrastructures, as well as supporting innovation, digital entrepreneurship and sustainable city development. A growing number of cities in the UK are progressing ambitious smart city programmes and projects across a range of themes, including governance, local economic development, citizen participation, urban living, the natural and built environment, and sustainable transport. The best of these programmes rank alongside those of the leading global smart cities.

With the increasing number of ongoing smart city projects, there is a growing interest in identifying the best approaches to evaluation and measurement of outcomes, essential to demonstrate the value created for cities. This has led to the SmartDframe research described in this report which supports MK:Smart, one of several exciting initiatives led by wide city-industry-university partnerships in Milton Keynes, a beacon itself of good practice for smart city developments.

This report provides a series of contemporary smart city case studies helping to exemplify city practices, and offers a timely contribution to city discourse about best practice approaches to evaluation and reporting of complex smart city developments. Cities everywhere will find this report of considerable insight and interest, in providing an overview and analysis of smarter city evaluation approaches that will support drives towards continuous improvement and city learning.

I hope that city authorities will enjoy reading this timely and enlightening report on smart cities.

Acknowledgements

Image Credits

Abstract

Global trends towards urbanisation are associated with wide-ranging challenges and opportunities for cities. Smart technologies create new opportunities for a range of smart city development and regeneration programmes designed to address the environmental, economic and social challenges concentrated in cities. Whilst smart city programmes have received much publicity, there has been much less discussion about evaluation of smart city programmes and the measurement of their outcomes for cities. Existing evaluation approaches have been criticised as non-standard and inadequate, focusing more on implementation processes and investment metrics than on the impacts of smart city programmes on strategic city outcomes and progress. To examine this, the SmartDframe project conducted research on city approaches to the evaluation of smart city projects and programmes, and reporting of impacts on city outcomes. This included the 'smarter' UK cities of Birmingham, Bristol, Manchester, Milton Keynes and Peterborough. City reports and interviews with representative local government authorities informed the case study analysis. The report provides a series of smart city case studies that exemplify contemporary city practices, offering a timely, insightful contribution to city discourse about best practice approaches to evaluation and reporting of complex smart city projects and programmes.

Executive Summary

Global trends towards urbanisation are associated with wide-ranging challenges and opportunities for cities. Smart technologies create new opportunities for a range of smart city development and regeneration programmes designed to address the environmental, economic and social challenges concentrated in cities. Whilst smart city programmes have received much publicity, there has been much less discussion about evaluation of smart city programmes and the measurement of their outcomes for cities. Existing evaluation approaches have been criticised as non-standard and inadequate, focusing more on implementation processes and investment metrics than on the impacts of smart city programmes on strategic city outcomes and progress.

Effective evaluation is important to prove the value of smart city programmes and to communicate the benefits delivered to city authorities and all city stakeholders in order to:

- inform city policy formation, planning, and decision-making;
- demonstrate the replicability and scalability of projects to city scale;
- enable cities to evaluate their progress against city performance indicators and metrics;
- work with industry on the business/value case for investment;
- support citizen engagement with the smart city work and enable citizens, including residents and local business and other organisations to benefit from new opportunities; and,
- support benchmarking studies and inter-city comparisons for city learning from best practice.

Considerable work is currently on-going to address challenges associated with smart city development and evaluation. This includes work on standards relevant to smart city development, by the International Standards Organization (ISO), European Committee for Standardization (CEN) and British Standards Institution (BSI). There is also significant work on evaluation driven by the European Commission (EC), including the EUROCITIES CITYKeys project. Moreover, there are a number of city measurement indicator frameworks specially designed to support city approaches to smart city evaluation, including *The European Smart Cities Ranking Model* developed by Vienna University of Technology/University of Ljubljana/Delft University of Technology (Giffinger et al., 2007), *The Smart City Reference Model* developed by Zygiaris (2013), *The Smart City Index Master Indicators* developed through the Smart Cities Council by Cohen (Smart Cities Council, 2014) and *The Smart City Maturity Model* developed by the International Data Corporation (IDC, 2013).

In addition, general city indexes are also a major source of indicators*,* measures and data to inform smart city evaluation and measurement, such as *The Ericsson Networked Society City Index* developed by Ericsson Ltd (2014) and *The 'Cities of Opportunity Index'* of leading cities developed by PricewaterhouseCoopers/Partnership for New York City (PwC/Partnership NYC, 2014). However, surprisingly few city indexes (that have published their methodology) have identified specifically smart city indicators and metrics. There is currently no standardised smart city measurement indicator framework accepted by cities to measure city performance, and to help evaluate progress against measurement indicators aligned with city strategies.

Addressing this, the SmartDframe project linked to the MK:Smart Programme led by The Open University, set out to examine city approaches to the evaluation of smart city projects and programmes and reporting of their impacts on city outcomes, through a series of city case studies. A selective number of 'smarter' UK cities were invited to participate in the SmartDframe project. Local government authorities representing Birmingham, Bristol, Manchester, Milton Keynes and Peterborough agreed to be interviewed about their smart city work, typically framed within future city programmes. There is no one definition of a city, and in the UK, formal city status is granted by Royal Charter. Milton Keynes is considered by many to be a new city, and a beacon of good practice for smart city developments, even though it has not yet been granted formal city status.

The key research questions underlying the case study approach were:

- How are cities approaching evaluation of their smart city programmes and projects?
- How effective are the approaches taken by cities to evaluation?
- How are cities reporting on the evaluation of their smart city work?

City reports and interviews with representative local government authorities informed a case study analysis. This revealed a dynamic and varied picture of cities approaches to evaluation and reporting of their smart city work.

Project-level evaluation

Typically evaluation of smart city work has been project-focused, and driven by funders' requirements which tended to be quite varied. A key issue for the cities was deciding on appropriate evaluation approaches to smart city projects, which were often innovations. A common view held was that evaluation should be appropriate to the maturity of the project, so that a premature evaluation is avoided that might crush emergent innovation opportunities. In the early maturity stages, the demonstration of the validity of a smart city concept may be sufficient.

Establishing baseline measures for projects was considered a good approach to demonstrate progress. Some of the cities were interested in the work of the British Standards Institution (BSI) Smart City Framework (SCF) on establishing baselines for mapping and tracking the benefits of city projects and programmes. A challenge for the cities is that it is typically more complex and difficult to demonstrate the effect of their smart city work on city outcomes than to measure progress.

City-level evaluation

The cities recognised the difficulty of proving the value of smart city activities, projects and interventions, and identifying the causal effects on targeted city outcomes. Most cities had not yet established a framework for evaluation and measurement at the smart city programme level, although they were aware of some on-going work, including the work of the BSI and EC which is driving the smart city evaluation agenda. Although the city evaluation work was at an early stage, the cities all had an interest in undertaking evaluation of their smart city programmes, and several were working in partnership with local universities and consultancies.

Effective evaluation

All the cities have begun to look at potential evaluation frameworks for their smart city programmes, although there were questions about existing evaluation frameworks and how meaningful they were. There were a number of criticisms of existing evaluation frameworks in terms of their choice of measurable indicators; whether they were arbitrary; whether they focused on easily measured indicators; and whether the selection was too specific when smart cities were considered multi-faceted. Moreover there were questions about evaluation frameworks: whether they were flexible and relevant to different city circumstances; whether they were capable of addressing the complexity of city systems and programme interventions; and whether they allowed for evolution and improvements in response to data-driven city mechanisms. There was also concern that city benchmarking for inter-city comparisons should not become a popularity contest, but instead support cities facing different challenges and opportunities with their smart city work.

City impacts of smart city work

City authorities were not wholly convinced that a specific smart city indicator evaluation framework is needed, when cities were primarily focused on measuring city outcomes aligned with strategic objectives and statutory obligations. Some cities preferred to evaluate the contribution of their smart city activities to existing city Key Performance Indicators (KPIs), rather than to establish new specific smart KPIs and measures. However, the cities recognised the challenges of how to align their smart city work with city strategies, and how to evaluate and measure the impacts on city outcomes.

Data intelligence is supportive of smart city evaluation with new mechanisms established for data generation and collection through city data-hubs, and the application of data analytics.

City reporting on smart city outcomes
All the cities interviewed have established processes for reporting on city performance related to measuring progress on achieving strategic city objectives, although their smart city programmes did not currently feed directly into their city performance reporting process, and were not therefore subject to a formal political reporting process. Some city authorities held the view that what was needed was a mechanism to report how the smart city programme was contributing to existing city KPIs, rather than to report specific smart KPIs. City authorities also discussed how smart city programmes were beginning to influence city decision-making, particularly in terms of city investment and development, which would benefit from rigorous evaluation and reporting mechanisms.

There were a variety of formal and informal city reporting mechanisms in place. Some formal reporting processes were established with the cities' funding bodies, and in the case of Birmingham there has been formal reporting to their Smart City Commission (SCC). Some cities have also established city performance dashboards with data feeds, as a form of reporting. However, several city authorities mentioned that they preferred to focus more on information, narrative and vision, rather than over-focus on city data, dashboards and performance reporting in their thinking about smart cities as liveable cities rather than digital cities. Cities also used various informal reporting mechanisms through public forums and open stakeholder meetings with partners and citizens.

Smart city evaluation and reporting challenges
The key challenges identified by the cities for smart city evaluation centred on how to measure the impact of smart city programmes and projects on wider city outcomes and prove the value of the programmes. The cities already have a significant amount of data at the project level, although were facing challenges of how to make sense of the data, and deciding which methodology to use to measure the impact of their smart city work on city outcomes. Cities were exploring the value of data intelligence to support city strategies, and beginning to develop the use of data intelligence, and to consider the opportunities afforded by smart technologies for smart city evaluation work.

Key reporting challenges for the cities interviewed were around establishing appropriate reporting structures, so that the smart city work is embedded in city management structures, to support communications about the value of their programmes and activities. Establishing formal reporting structures is also important so that smart city work is reported through the management structures of the wider community partnership of *all* the organisations responsible for delivery of city services and smart city outcomes, as well as the wider city stakeholders. Another key reporting issue is how to make good use of data intelligence to communicate the value of smart city work generally, supported by both standards development and interoperability in the reporting criteria and data used in evaluation and reporting.

Moving forward
This report provides a series of contemporary smart city case studies that exemplify city practices, offering a timely, insightful contribution to city discourse about best practice approaches to evaluation and reporting of smart city project and programme outcomes for complex city systems. In general, the cities were already participating in a number of European and UK smart city development and evaluation initiatives to support continuous improvement and city learning. The cities were also exploring the value of data intelligence, and beginning to consider the opportunities afforded by smart technologies for data intelligence driving evaluation and reporting of smart city work.

A Tale of Evaluation and Reporting in UK Smart Cities

Contents

List of Abbreviations

BIS – Department for Business Innovation and Skills

BSI – British Standards Institution

BT – British Telecom

CEN – European Committee for Standardization

EC – European Commission

EIP – European Innovation Partnership

EIP-SCC – European Innovation Partnership on Smart Cities and Communities

EU – European Union

GSMA – Groupe Speciale Mobile Association

HEFCE – Higher Education Funding Council

ICT – Information and Communication Technology

IDC – International Data Corporation

IoT – Internet of Things

IR – Integrated Reporting

ISO – International Standards Organization

KPI – Key Performance Indicator

MOOC– Massive Online Open Course

OECD – The Organisation for Economic Co-operation and Development

OU – The Open University

PAS – Publicly Available Specification

SCC – Smart City Commission

SCF – Smart City Framework

STS – Science and Technology Studies

UK – United Kingdom

1. Introduction

Global trends towards urbanisation are associated with wide-ranging challenges and opportunities for cities, creating complex pressures on city environments, infrastructure, buildings, networks, resources and people. Cities account for an estimated 60-80% of global energy consumption and 75% of carbon emissions (UN, 2015), although generate an estimated 80% of global GDP (BIS, 2013a), whilst covering approximately only 2% of the world's land mass (UN, 2015). Some 54% of the world's population now live in urban areas, with predictions to increase to 66% by 2050, although in the UK and Europe higher proportions of the population already live in cities (UN, 2014). City authorities face challenges of developing the infrastructures and services needed to help people live, work, travel and play - ensuring that cities can develop economically, whilst protecting the environment and quality of life for citizens.

The rise of the smart city and smart city thinking is a direct response to such challenges, as well as providing a means of integrating fast evolving technology into our living environment. Smart technologies offer cities exciting solutions for new services provision and integrated city infrastructures, as well as creating opportunities to support innovation, digital entrepreneurship and sustainable city development. Many of the larger cities in the UK have established a wide range of smart city development and regeneration programmes designed to address the environmental, economic and social challenges concentrated in cities. This work will shape our future cities and support Europe's 2020 vision of a smart, sustainable and inclusive economy[1].

In the European Union (EU), almost 90% cities with over 500,000 inhabitants are smart cities (EU Directorate-General, 2014). Relative to EU countries, the UK has amongst the highest number of smart cities, with more than 31 cities with smart programmes (EU Directorate-General, 2014) which is almost half of the 69 UK cities granted Royal Charters. Cities represent an *'economic engine'* (BSI, 2014a, p4) and provide a proving ground for smart technologies as places where most of the population live and work. The UK Department for Business, Innovation and Skills (BIS) *(*BIS, 2013a, p.i) notes *'Cities can be great proving grounds for technologies, providing opportunities for people to invent new things, and opportunities to test and sell them.'* As central hubs, cities are expected to play a key enabling role for proving smart technologies, providing a context for achieving the maximum impact and benefits from innovative solutions.

1.1. The smart city context for evaluation and measurement

While smart city programmes have received much publicity there has been less discussion about the evaluation and measurement of smart city programme outcomes. The '*Global Innovators: International Case Studies and Smart Cities'* report noted the inadequacy of existing evaluation approaches which tended to be non-standard, and focused on implementation processes and investment metrics rather than city outcomes and impacts (BIS, 2013b). However, some smart cities are moving beyond this narrow focus to examine metrics to evaluate the impacts of programmes on people's lives, for example Rio de Janeiro is looking at 'citizen value', and Boston is evaluating the benefits of the city systems (BIS, 2013b).

The inadequacy of evaluation mechanisms may be partially explained by the experimental innovative nature of many smart city projects (GSMA, 2013). Peter Madden (2015), Chief Executive of the Future Cities Catapult UK, argued for developing better evaluation approaches in his keynote

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[1] http://ec.europa.eu/europe2020/index_en.htm

speech at the Milton Keynes Future Cities Conference 2015. *'Many of these big experiments, test cases and projects in cities in the UK are done as one-offs and it kind of gobsmacks me how much money we spend without ever baselining? What was it like? What did we spend? What worked? What got better and what didn't? People just don't do it and then it means that when you come to the next one you're starting from scratch again. …What are the environmental costs? The social costs? And particularly the economic costs and benefits? And what do local authorities get from investing in this? Because if we don't have the business case and the replicability, there are always going to be one off tests and pilots reliant on public subsidy.'*

Effective evaluation is important to prove the value of smart city programmes and the benefits delivered to city authorities and all city stakeholders in order to:

- inform city policy formation, planning, and decision-making;
- to demonstrate the replicability and scalability of projects to cities;
- enable cities to evaluate their progress on city performance indicators and metrics;
- work with industry on the business/value case for investment;
- support citizen engagement with the smart city work and enable citizens, including residents and local business and other organisations to benefit from new opportunities; and,
- support benchmarking studies and inter-city comparisons and city learning from best practice (see EIP-SCC, 2013).

Work on standards relevant to smart city development, by the International Standards Organization (ISO), European Committee for Standardization (CEN) and British Standards Institution (BSI), is available to support work on evaluation and measurement. This includes ISO's work on *'Sustainable Development of Communities'* ISO

37120:2014[2] and ISO/DIS 37101[3], supported by work on the Global Cities Indicators (GCI) system[4]; ISO's work on *'Smart Community Infrastructures'* with ISO/TR 37150:2014[5] and ISO/TS 37151:2015[6]; and the BSI's proposed ISO standard for *'Global City and Smart City Indicators'* also supported by the GCI system. The BSI has also undertaken a significant body of work to develop smart city standards[7] commissioned by the UK government BIS Department (BSI, 2014c).

The European Commission (EC) have funded work on smart city measurement with the EUROCITIES CITYKeys project[8], which works with cities to develop and validate key performance indicators and data collection procedures to support monitoring and comparison of European smart city solutions. There are also a number of city measurement indicator frameworks available to support city approaches to smart city evaluation. This includes several specially designed smart city measurement indictor frameworks:

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[2] ISO 37120:2014 Sustainable development of communities: Indicators for city services & quality of life http://www.iso.org/iso/catalogue_detail?csnumber=62436

[3] ISO/DIS 37101 Sustainable development of communities -Requirements with guidance for resilience and smartness http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=61885

[4] The Global Cities Indicators (GCI) system has been tested with over 250 cities and includes city profile; city services; and quality of life indicators http://www.cityindicators.org/themes.aspx

[5] ISO/TR 37150:2014 Smart community infrastructures -- Review of existing activities relevant to metrics http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=62564

[6] ISO/TS 37151:2015 Smart community infrastructures -- Principles and requirements for performance metrics http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=61057

[7] BSI Standards Publications http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/

[8] http://www.citykeys-project.eu ; http://www.eurocities.eu/eurocities/projects/CITYKEYS-Smart-city-performance-measurement-system&tpl=home

- *The European Smart Cities Ranking Model* developed by Vienna University of Technology/University of Ljubljana/Delft University of Technology which offers a useful comprehensive framework of smart city indicators defined across six domains or characteristics including Smart Governance, Economy, People, Living, Environment and Mobility, and is articulated in terms of 31 factors, and 74 development and performance indicators (Giffinger et al., 2007) [9].
- *The Smart City Reference Model* developed by Zygiaris (2013) which offers a holistic conceptualisation of the smart city outlining seven interconnecting smart city layers in terms of sustainable development stages, and a limited set of Key Performance Indicators (KPI). Smart city layers include the: (0) city foundation, (1) green city, (2) interconnection, (3) instrumentation, (4) open integration, (5) application and (6) innovation layers (Zygiaris, 2013).
- *The Smart City Index Master Indicators* developed through the Smart Cities Council by Cohen (Smart Cities Council, 2014) which identifies the same key smart city domains as the European Smart City Ranking Model, although this framework includes a different set of indicators[10].
- *The Smart City Maturity Model* developed by the International Data Corporation (IDC, 2013) identifies five smart city maturity phases based on benchmarking cities against maturity indicators. The maturity phases include the: initial '*Ad hoc*' project planning phase; '*Opportunistic*' proactive project deployments phase with emerging collaborative partnerships and strategies; '*Repeatable*' projects phase with process implementation, stakeholder buy-in and accompanying strategy formulation

documentation; '*Managed*' phase with formal systems for work/data flows driving performance management and impactful outcomes with technology and standards in place; and '*Optimized*' phase with a sustainable city-wide platform within the city system of systems established to enable continuous improvement of strategy, ICT and governance[11].

General city indexes are also a major source of indicators, measures and data to inform smart city evaluation and measurement. In their review of 150 global city indexes and comparative city benchmarking studies, Moonen and Clark claim that '*The measurement of city performance is one of the critical ways in which we can assess the complexity of urban change, and judge which approaches are successful or not*' (Moonen and Clark, 2013, p2). An examination of city indexes that have published their methodology showed that surprisingly few city indexes identify specific smart city indicators and metrics relevant to smart cities, with the following few exceptions:

- *The Ericsson Networked Society City Index* developed by Ericsson Ltd (2014) which measures the ICT maturity of major cities in terms of ICT infrastructure, readiness, and usage against economic, social and environmental outcome dimensions, corresponding with the development, diffusion and adoption maturity phases of innovation[12].
- *The 'Cities of Opportunity Index'* developed by PricewaterhouseCoopers/Partnership for New York City (PwC/Partnership NYC, 2014) for examining leading cities, offers a comprehensive set of city indicators that includes 'Smart' indicators covering measures of 'Intellectual Capital and

[9] http://www.smart-cities.eu/?cid=1&ver=3
[10] http://smartcitiescouncilalert.com/resources/smart-city-index-master-indicators-survey
[11] http://az370354.vo.msecnd.net/publicsector/citynext/whitepapers/IDC%20Government%20Insights'%20Smart%20City%20Maturity%20Model_IDC.pdf
[12] http://www.ericsson.com/res/docs/2014/networked-society-city-index-2014.pdf

Innovation', 'Technological Readiness' and 'City Gateway' city indicators, as well as various general 'Quality of Life' and 'Economic' indicators[13].

However, there is no accepted standardised smart city indicator system to measure city performance and progress aligned with smart city objectives and Europe 2020 strategies, according to the European Innovation Partnership on Smart Cities and Communities (EIP-SCC, 2013). The EIP-SCC observed that '…*there is presently no single, broadly-accepted indicator framework that reflects the 'smart city' approach*…'. (EIP-SCC, 2013, p.16).

Greater clarity about smart city definitions would be helpful. Many smart city definitions have been developed and applied (Albino et al., 2015). However, the British Standards Institution (BSI, 2014a, p7) claim '*There is no clear definition of what it means to be a Smart City or how to assess what contribution specific infrastructure, systems and services solutions and investments can make to Cities' performance'.*

In the Publicly Available Specification (PAS180), BSI defines smart technology as '*autonomous or semi-autonomous technology systems'* (BSI, 2014b, p5) and the smart city as requiring '*effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens'* (BSI, 2014b, p12).

A key definitional issue is that most so-called smart cities are at different stages of becoming smart future cities, as identified by IDC's Smart City Maturity Model (IDC, 2013). Smart city programmes are typically retrofit solutions set within a future city vision. In this context, smart cities capture our imagination as a vision for future cities, as noted by Moir et al., (2014, p 4): *'Smart cities' has become the most popular formulation for the future*

city, and is becoming a globally recognised term, … The 'smart city' has displaced the 'sustainable city' and 'digital city' as the word of choice to denote ICT-led urban innovation, and new modes of governance and urban citizenship'.

However, the BSI caution there is '*no one-size-fits-all model'* for developing future smart cities (BSI, 2014c, p3). To address related evaluation challenges, the EIP-SCC have specified a set of recommendations for the development of a standardised smart city indicator system. This should be aligned with smart city strategic objectives and Europe 2020 strategies, based around 20/20/20 carbon reduction, renewable energy and energy efficiency targets[14]; technological innovation; citizen engagement; transparency; and social inclusion. This should address the operational level where measurement should be conducted over time based on real-time data as much as possible, and be evidenced against baselines and strategic targets. This should support cities' evaluation of their progress towards becoming smart cities, and support benchmarked comparisons with other cities. It should be developed through a stakeholder process that engages relevant research and community stakeholder groups, whilst being open to improvement and the integration of future additional innovations. The EIP-SCC also recommend it should build on existing urban development measurement indicators and be aligned with an understanding of different European cities, for example in terms of their population density, socio-economic context, geography, and political and governance administrations. The development of a smart city indicator system to this specification would support progress monitoring, inter-city benchmarking and comparisons, in order to demonstrate the benefits of smart city programmes to multiple city stakeholders and inform city policies and industry investments (EIP-SCC, 2013).

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[13] http://www.pwc.com/us/en/cities-of-opportunity/2014/pdf-download.jhtml

[14] http://ec.europa.eu/clima/policies/strategies/2020/index_en.htm

2. Research Questions and Methods

Following a review of publications about smart city and future city programmes by UK councils, UK government departments, EU, industry and academia, the SmartDframe project aimed to interview city authorities in UK-based cities about their strategic approach to addressing city challenges through smart city programmes and projects, and their approach to the evaluation and measurement of outcomes.

The key research questions investigated were:

1. How are cities approaching evaluation of their smart city programmes and projects? This addressed issues of leadership; stakeholder partnership and engagement; the key influences on their approach; the application of success indicators and measures; and data generation, collection, analysis and use for evaluation.
2. How effective are the approaches taken by cities to evaluation? This addressed issues of: the purpose of evaluation; city awareness of relevant work; the potential for improving evaluation approaches; and contribution of approaches to inter-city comparisons and city learning.
3. How are cities reporting on the evaluation of their smart city work? This addressed city reporting on the impacts of smart city work, and the contribution to decision-making and improvements in city outcomes.

2.1. Selection of Cities

Local government authorities representing a number of '*smarter*' UK cities from Birmingham, Bristol, Glasgow, London, Manchester, Milton Keynes and Peterborough were invited to participate in the SmartDframe research study. In the UK, traditionally the presence of a cathedral has been the essential criterion for defining a city, whereas since the 19th century other criteria including population size have helped to establish formal city status granted by Royal Charter. Milton Keynes is considered by many to be a new city, and a beacon of good practice for smart city developments, although it has not yet been granted formal city status by Royal Charter.

Representatives of Glasgow City Council were busy with an existing evaluation process for their Future Cities Demonstrator project, and declined to participate in the SmartDframe project within the timescale. Moreover, although representatives from The Greater London Authority were interviewed for the SmartDframe project, this initial research in London is not reported here as further work is needed to be fully representative of London's wider Smart City programmes. Hence the SmartDframe case studies and research report is focused on interviews with city authorities in Birmingham, Bristol, Manchester, Milton Keynes and Peterborough who all agreed to be interviewed about their city's approach to evaluation and reporting of smart city projects and programmes which was frequently framed within their future city programmes.

The cities interviewed ranged in population size, which is considered a useful indicator for city stratification (EC, 2012)[15]. Birmingham represents extra-extra-large cities (XXL) with over 1,000,000 people; Manchester represents extra-large cities (XL) with populations of 500,000-1,000,000; Bristol and Milton Keynes (as a new city[16]) represent large-sized cities (L) with populations of 250,000-500,000; and Peterborough represents medium-sized cities (M) with populations of 100,000-250,000. Specific cities not covered in this initial report on the SmartDframe study are small cities with populations of between 50,000-100,000; and

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[15]http://ec.europa.eu/regional_policy/sources/docgener/focus/2012_01_city.pdf
[16] Milton Keynes has not yet been granted formal city status with a Royal Charter

global cities such as London with more than five million inhabitants.

Further information on the cities is available, for example through the urban observatory[17], which builds on urban data collection to visualise the complex, urban themes of international cities' forms and flows across themes of work, movement, people; public services and systems.

Most of the cities that participated in the study were in the early maturity phases of their smart city development, particularly the initial phases of '*Ad hoc*' project planning and '*Opportunistic*' proactive project deployments, based on IDC's Smart City Maturity Model (IDC, 2013). Indeed Birmingham is the only participating city that had adopted a formal smart city strategy and roadmap.

The cities selected were particularly active smart cities that have been successful in securing UK and European funding to set up smart city or future city programmes, including from Innovate UK, Higher Education Funding Council for England (HEFCE) and the EC. The funding was helping cities to progress ambitious smart city programmes and projects across a range of themes, including local governance; local economic development, citizen participation and inclusion; urban living; the built environment; and sustainable transport.

All five cities were also actively working with other cities across Europe, through networks such as EUROCITIES[18], the European Innovation Partnership on Smart Cities and Communities (EIP-SCC)[19] and as part of European-funded projects. The larger cities Birmingham, Bristol and Manchester were members of the UK Core Cities initiative[20]. Also Peterborough has an active role in the

Small Giants Initiative[21], which works with small and medium-sized cities on the smart cities agenda. In terms of smart city evaluation, both Manchester and Birmingham were both involved in EC-funded smart cities evaluation projects, including CITYKeys[22] and the EUROCITIES smart city forum.

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[17] http://www.urbanobservatory.org
[18] http://www.eurocities.eu/eurocities/forums/knowledge-society&tpl=home EUROCITIES Smart City Forum
[19] http://ec.europa.eu/eip/smartcities/
[20] http://www.corecities.com/

[21] http://www.peterboroughdna.com/peterborough-dna---a-small-giant/
[22] http://www.citykeys-project.eu

3. Overview of City Governance and Strategy

The cities addressed in this report are based in England, where particular Council or Local Authority governance structures are applicable[23]. Birmingham and Manchester are Metropolitan Boroughs, whilst Bristol, Milton Keynes and Peterborough are Unitary Authorities; Bristol also has an elected mayor.

At a high level, many councils/local authorities report on their citywide or corporate performance through the Sustainable Community Strategy, which is developed as a long-term plan with broad strategies in partnership with local bodies and interest groups e.g. with the health service, universities, business and voluntary sectors. Council reporting on city performance is driven by their Council/Corporate Plans which establish the vision, strategies, objectives and action plans for councils, and identifies the Key Performance Indicators (KPIs) and targets linked to key city strategies, e.g. housing and economic strategies.

Some of the council strategies and action plans are statutory documents, such as the Local Transport Plan and Local Development framework, whereas others are voluntary, for example the Climate Change Strategy and Smart City Strategy. This helps explain why most of the cities do not have a formal smart city strategy or roadmap yet, with the exception of Birmingham, which has a Smart City Roadmap[24] although Milton Keynes and Peterborough were in process of reviewing whether to develop or adopt a formal smart city road map. At present many of the cities framed their smart city work within their future city programmes and focussed their

efforts on delivering innovative smart city projects.

In their approach to smart cities, all the cities in this study were using a range of smart technologies and data to address city challenges and deliver sustainable city outcomes. All the cities had a smart city vision that corresponded to BSI's articulation of the smart city vision in the PAS181 Smart City Framework (SCF), with elements of promoting a vision that is citizen-centred; digitally inclusive and connected; open with data; and collaborative (BSI, 2014c). The Bristol and Peterborough smart city vision has a strong emphasis on environmental and citizen engagement work; whereas Manchester's vision makes particular reference to city regeneration; while Birmingham, Milton Keynes and Peterborough have a strong focus on economic growth.

All the cities have established partnerships bringing together diverse public, private, voluntary and community sectors to deliver projects, related to connectivity, sensor networks, open data portals, energy, mobility, enterprise, innovation, skills and education. Birmingham City Council have already established a Smart City Commission; whereas other councils build on formal city partnerships for delivering strategies and services, for example Connecting Bristol[25], Manchester Partnership[26] and Opportunity Peterborough[27]; although all the cities have established flexible partnerships emerging from their smart city projects. Detailed case studies of the five smart cities and their approaches to evaluation and reporting are presented in Sections 3.1-3.5.

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[23] https://www.gov.uk/understand-how-your-council-works/types-of-council
[24] http://digitalbirmingham.co.uk/project/the-roadmap-to-a-smarter-birmingham/

[25] http://www.connectingbristol.org/
[26] http://www.manchesterpartnership.org.uk/mancheste rpartnership/site/index.php
[27] http://www.opportunitypeterborough.co.uk/about-opportunity-peterborough/

3.1. Birmingham

3.1.1. Smart city strategy and action

Birmingham is a city covering an area of 286 km^2 where over 1.1 million people live. The local government body responsible for city governance is Birmingham City Council, a Metropolitan Borough part of the West Midland Metropolitan County.

Birmingham established a Smart City Commission in 2012 which includes leading figures from business, universities and the public sector and is supported by Digital Birmingham[28], the city's digital partnership led by the Council. In 2013 they published a Smart City Vision[29], focussed around creating an environment to support economic growth for Birmingham's businesses and citizens. This was followed by the Birmingham Smart City Roadmap[30] with 35 actions intended to influence the city's approach to creating a

sustainable and better future for its citizens. This identified challenges for the city including around employment, skills gaps, health inequalities, effective mobility and carbon reduction targets. Actions were grouped into three themed areas: '*Technology and Place*' covering connectivity, digital infrastructure, open data and information markets; '*People*' covering digital inclusion, citizens' skills and employment, and digital innovation; and '*Economy*' also covering health and wellbeing, ICT with energy efficiency, and mobility.

The Birmingham Roadmap includes on-going projects, projects coming on stream and aspirational projects. Existing smart city projects funded through national and local investment include providing high speed broadband connectivity and free Wi-Fi in public buildings; creating a digital academy programme to support SMEs to improve their digital skills; and creating an open data portal. There is a Birmingham Smart City blog[31], run by the community, a place to share ideas and

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[28] http://digitalbirmingham.co.uk/

[29] http://s3-eu-west-1.amazonaws.com/digitalbirmingham/resources/Birminghams-Smart-City-Commission-Vision-FINAL-VERSION.pdf

[30] http://digitalbirmingham.co.uk/project/the-roadmap-to-a-smarter-birmingham/

[31] https://birminghamsmartcity.wordpress.com/

developments for making Birmingham a smarter city. They are also a partner in Smart Spaces[32], a European project piloting energy saving approaches using ICT. They said '*One of the things the Commission is actively doing is understanding what activities we do and should do that have a real impact. It is not just about delivering projects, what we want to do is identify where we are making the impacts, how we get things to change, what difference are we making to citizens and businesses? So we are very engaged in that agenda'*.

3.1.2. Approach to evaluation

Digital Birmingham is leading thought about how to evaluate their Smart City Roadmap and progress against designated actions[33]. '*The actions, ranging from research to projects, set a direction of travel and will be managed and evaluated against their own set of indicators, in line with the lead partner's requirements and grant funding criteria.*' (Digital Birmingham, 2014, p15).

Digital Birmingham has offered initial suggestions about evaluation to their Smart City Commission, however *'they did not want to get side-tracked on measurement'*. So to-date, the focus has been getting projects up and running, and measuring progress at the project level: for example, they are measuring the number of smart city projects started and their progress status; and their project partners are measuring Key Performance Indicators (KPIs) for each project. They have also produced evaluation reports on smart city projects, such as Smart Spaces, working with social scientists and statisticians on data interpretation, noting that '*without having a person who does the evaluation the data is useless and this is where cities often fall down*'.

From the city perspective, they were more interested in how developments enable the delivery of city service outcomes e.g. healthcare improvements and better flood prevention, rather than measuring city KPIs that are specifically smart. It '*was a purposeful decision [by the Commission] not to have individual KPIs at the roadmap level, but instead to build a framework'.* They were particularly interested in using the PAS181 Smart City Framework[34] produced by the British Standards Institution (BSI, 2014c). They plan to work with their partners KPMG[35] on evaluation once they have achieved greater maturity with the city Roadmap deliverables.

Birmingham '*have started the process of looking at how data intelligence works across the city*' informing evaluation and reporting. The City Council are bringing data assets together as part of their smart city approach, so that the Council becomes more intelligent in how and where they intervene. In addition, other organisations in the city are beginning to work with them to see how they can make their data available.

The European Commission (EC) has a significant influence on Birmingham's approach to evaluation. For example, the EC have established obligations for every project funded under their Smart City Lighthouse projects call[36], to provide clear measurement and input their data to other EC projects. Birmingham is currently involved with EC-funded projects on smart city measurement frameworks, such as the EUROCITIES CITYKeys project[37]. They also looked at other evaluation models such as Genoa[38] which has a geographical approach to KPIs; ISO 37120:2014 '*Sustainable development of communities: Indicators for City Services and*

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[32] http://www.smartspaces.eu/
[33] https://birminghamsmartcity.files.wordpress.com/2014/03/birmingham_smart_city_roadmap_03_03_20141.pdf

[34] http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/PAS-181-smart-cities-framework/
[35] https://home.kpmg.com/uk/en/home.html
[36] http://ec.europa.eu/eip/smartcities/about-partnership/how-does-it-work/index_en.htm
[37] http://www.citykeys-project.eu/
[38] http://www.genovasmartcity.it/index.php/en/

Quality of Life'[39]; the IDC's Smart City Maturity Model[40] which developed indicators aligned with five maturity stages in the development of smart cities; and have also worked with Arup[41] to trial a smart city framework mainly focused on energy.

3.1.3. Effectiveness of evaluation approach

Birmingham's evaluation of their Smart City Roadmap has to-date been focussed at a

Birmingham: © Andy J Moore.

project level. Their Smart City Commission considers which smart city projects and activities Birmingham needs to have to make a difference to citizens and businesses, but the next stage is for them to develop an evaluation framework that enables them to measure city impacts.

Digital Birmingham reviewed a number of possible evaluation approaches and, whilst most frameworks focus on quantitative measures, they thought it necessary to include both qualitative and quantitative measures. They find it easy to collect data on

smart city projects and easy to automate data streams, although they said their key challenge relates to making sense of data, and linking project outputs to overall outcomes in the city. This would be addressed through partnerships with scientists and statisticians.

3.1.4. Reporting on city outcomes and contribution to decision-making

Digital Birmingham manages the administrative side of the Commission and

reports regularly on the Birmingham Smart City Roadmap. Reporting to the Commission takes place on a quarterly basis with additional meetings as required. The Commission aims to align the aims, actions and outcomes of their Roadmap themes covering '*Technology and Place*', '*People*' and '*Economy*', although they find this difficult to achieve due to limited resources. Birmingham City Council has hundreds of KPIs that measure the performance of Birmingham's Sustainable Community Strategy which sets out the overall objectives for the city, although the Smart City Roadmap does not currently feed into this reporting process.

The reporting of smart city outcomes influences decision-making in the city through

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[39] http://www.iso.org/iso/catalogue_detail?csnumber=62436
[40] https://www.idc.com/getdoc.jsp?containerId=IDC_P23432
[41] http://www.arup.com/

the Commission, and this also influences reporting through the Council management to the Cabinet Member, which enables the smart city agenda to be driven politically. Birmingham's smart city work is included in their Council Leader's Priority Statements as part of the Council Corporate Report, which goes to Cabinet. A key role for Digital Birmingham is making links, encouraging a partnership approach, and breaking down silos to support continuous city improvement.

3.1.5. Challenges and improvements

Digital Birmingham recognised that without a baseline, a city cannot measure change or progress on their smart city journey - also important for city investment decisions. At the project level they said a key challenge is '*if you have no way to evaluate all these different projects to outcomes then how do you evaluate which ones have the biggest impact and which ones other cities could replicate*?' They were also interested in evaluating the collective impacts of city projects to inform city outcomes, and were planning to ensure their smart city demonstrator projects have direct measurable impacts, for example on city health and employment outcomes.

At the city level, they noted that there could be a basket of city indicators and measures applied to demonstrate that a city is a smart city, although it is very difficult '*trying to relate the inputs to an outcome'*. One of the key issues they identified was deciding which evaluation approaches to use and they

questioned how meaningful some were. Digital Birmingham have explored a number of smart city evaluation models, although found many were based on an arbitrary selection of a number of types of indicators, and focused on what is easily measurable, or became too specific about what a city must achieve to become smart when smart cities are multi-faceted. There were also questions of whether a specific smart city measurement framework is needed as the city already produces measures and statistics e.g. on accidents, mortality rates, deprivation levels etc. that are automatically benchmarked for cities as part of their regulatory reporting.

Digital Birmingham mentioned some concern that smart city benchmarking might become a '*popularity contest*' and '*comparing cities like for like'* would not necessarily reflect the different challenges that individual cities face. However they thought it useful to have an evaluation standard or framework that encourages different sectors to report data in a standardised way, so that it becomes easier to assess the outcomes of smart city project activities.

Communications are regarded as an important aspect of smart city evaluation and Digital Birmingham observed that Birmingham should have '*a reporting structure that goes back into the management structure of organisations responsible for the city outcomes, so they get an understanding of how projects are contributing*'.

3.2. Bristol

3.2.1. Smart city strategy and action

Bristol is a city with a population of around 442,500 situated in the South West of England. Bristol citizens voted for their first elected mayor in 2012 who is responsible for the governance of the city along with Bristol City Council, a Unitary Authority covering 110 km².

The City Council established Smart City Bristol in 2011, a collaborative programme between the public sector, business and community. It is led by Bristol Futures, a Directorate in the Council, whose vision is to ensure that Bristol becomes a resilient, sustainable, prosperous, inclusive and liveable place. The work is delivered through a public-private-people partnership with an emphasis on citizens working through Connecting Bristol[42], the City's digital partnership. The aims of Smart City Bristol are embedded within the Council's Service Plans rather than a Smart City Strategy, which is not currently in place.

Smart City Bristol developed following a Smart City Report[43], commissioned in 2011, which undertook an independent analysis of how smart city technologies could contribute to Bristol's carbon reduction objectives. This benchmarked Bristol against other world cities and offered a set of objective recommendations to achieve further emissions reductions and provide citywide economic benefits. Projects were initially developed around three key strands and their recommendations: Smart Energy, Smart Transport, and Smart Data, although the focus has since expanded into new areas including health. Two of Bristol's flagship projects are the Bristol Future City Demonstrator[44] which supports the development of digital infrastructure and the city as a living lab funded by Innovate UK; and Bristol is Open[45] a joint venture with the University of Bristol which provides an open digital infrastructure

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[42] http://www.connectingbristol.org/

[43] http://www.slideshare.net/Bristolcc/bristol-smart-city-report-7579696
[44] https://connect.innovateuk.org/documents/3130726/6091879/Feasibility+Study+-+Bristol+City+Council.pdf/4269233f-cd8b-47da-9f0b-58a27294a684
[45] http://www.bristolisopen.com/

for testing solutions in transport, health, governance and the workplace funded by a mixture of local, national and European funding, including private sector investment.

3.2.2. Approach to evaluation

At the start of their smart city journey, Bristol City Council commissioned UK-Government-funded work to benchmark their activities against other international cities, which resulted in a Smart City Benchmark Report[46] that contributed to their Smart City Report. This identified types of smart activities in cities at an international level, and focussed analysis looking at data and case studies in three key areas: smart meters and grids; transport; and city dashboards.

Evaluation of Bristol's smart city projects currently happens at a project level, although '*when it comes to evaluation of the overarching impact of the general smart city approach, there is nothing specific'* in place. Funding bodies require evaluation of the impacts of discrete projects, and this is therefore built into project delivery with each project having a set of Key Performance Indicators (KPIs), with the evaluation led by the project partners.

The European Commission (EC) were identified as having a particular influence on Bristol's approach to evaluation; for example, they have been using evaluation methodologies developed by the EC on energy projects such as 3eHouses, a smart energy project[47], and were also developing smart city KPIs with San Sebastian and Florence in their European-funded STEEP project[48] which is developing an Energy Master Plan using a systems thinking methodology in combination with open data to achieve carbon reduction targets linked to KPIs.

Bristol City Council have identified opening up city data, generated and collected in the city, an important opportunity for the city. They note this can '*unlock new opportunities and interesting information and knowledge'* and contribute to city performance measures. For example, they were collecting data about real-time traffic congestion from automatic number plate recognition cameras and using this to estimate average speeds across the city, as an indicator of congestion in the city. They also have a project where communities can design, develop, build, own and manage an array of data sensors within their own community spaces, generating data that is valuable to communities. This data is then shared through the Bristol Open Data Portal[49] and is available to contribute to city reporting.

3.2.3. Effectiveness of evaluation approach

The evaluation of Bristol's smart city work is currently focussed at the project level and particularly influenced by the EC. However, they recognise that their smart city work needs to deliver something tangible for the city in terms of meeting the city's key challenges and opportunities. The evaluation also needs to contribute towards strategies such as the Mayor's Vision for Bristol[50] and they mentioned that they needed '*to align activities directly to the City's strategic outcomes to demonstrate what impact we are having and that we are acting strategically'*.

The difficulty faced is how to measure the overall impact of the programme on city outcomes. They have not yet established an evaluation framework to do this and said '*it is challenging enough to define what a smart city is and if you don't know what precisely it is, then how do you know what to measure*?'

The Council already measures around 150 KPIs, including environmental, economic and social KPIs linked to their Council/Corporate

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46 http://www.slideshare.net/Bristolcc/smart-city-benchmark?related=1
47 http://cordis.europa.eu/docs/projects/cnect/1/250491/080/reports/002-ARES3404476FinalReportfinalversion.pdf
48 http://www.smartsteep.eu/cities/

49 https://opendata.bristol.gov.uk/
50 https://www.bristol.gov.uk/mayor/a-vision-for-bristol

Plan[51] and wider city strategies. However, they said '*there is a real ambition to reduce the number of KPI's*' to provide a better focus and use of resources. They thought adding a new suite of smart city KPIs might be counterproductive and was not necessary as '*you just need KPIs about improving the general quality of the city and the contribution made by introducing advanced smart technologies*' rather than developing extra KPIs.

stakeholder consultation and engagement is important, where people can both offer support and be critical of the progress. They said '*sharing with stakeholders is enormously valuable to keep stakeholders on-board so they can see that the input that they have given has resulted in an outcome for the city*'.

Their smart cities work is starting to contribute to decision-making in the city; for example, in the early years of the programme they spent a lot of time working on smart energy projects, which led the Council to

Bristol: © Ian Packer.

3.2.4. Reporting on city outcomes and contribution to decision-making

Reporting on Bristol's Smart City Programme happens within the City Council. Reports go to the Director of Bristol Futures who reports to the Senior Leadership Team, comprising the Chief Executive and other Department Directors.

They also recognise the importance of reporting to wider city stakeholders, '*we used to have open stakeholder meetings and annual reviews through Connecting Bristol*'. As the programme has grown they have had less time, although they recognise open

launch an Energy Company[52] that aims to be '*smart from the start*'. Through connecting people and projects, Bristol is working in a practical way to ensure the smart city programme contributes to continuous improvement in the city.

3.2.5. Challenges and improvements

Communications are important in smart city work, and difficulties defining the smart city was identified as a key barrier to reporting on city outcomes. They observed '*people don't understand what the smart city is; even people who work in it struggle to articulate what a smart city might be to each other*'.

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[51]https://www.bristol.gov.uk/documents/20182/33575/Corporate+plan+2014_0.pdf/fd45331c-fa96-4b21-80c7-bb57295101b8

[52] https://bristol-energy.co.uk/

Bristol City Council believed that an effective smart city evaluation framework needs to be set within a narrative that explains how the smart city programme is improving the liveability of the city. They noted '*It needs to relate to how this is a better place to be, how your life has improved or how you can get a better job*', rather than a framework based solely on quantitative measures such as the number of '*intelligent lights you have got in the city or how much of the city is covered by Wi-Fi*'. They added '*the outcomes of becoming a smart city are not digital…they are about how it feels to be in that city; smart cities are about liveable cities*.'

Bristol City Council maintained that smart city evaluation should incorporate a citizen-centric consultation approach. They said '*it's about going out and asking citizens/stakeholders for their views*'. The Council were interested in establishing a formal people panel bringing together citizens, business and visitors to the city to identify whether changes implemented as part of their smart city work were having a positive impact on people's lives.

3.3. Manchester

3.3.1. Smart city strategy and action

The city of Manchester is located in the North-West of England and has a population of around 520,200. Manchester City Council is the local government body responsible for the city area covering 116 km^2. The City Council is a Metropolitan Borough, part of the Metropolitan County of Greater Manchester.

Manchester has a Smarter City Programme[53] led by the City Council, which is exploring ways of making the city work better through use of technologies. It '*takes things that the city is already doing around transport, health, environment and energy efficiency and aims to encourage further investment, through supporting pilot projects and working with partners in the universities, business, and the public sector*'. It offers a future city framework for Manchester focused on 6 key themes - live, work, play, move, learn and organise - to achieve better outcomes for the city and its citizens. The Council are involved with over 30 smart city projects in the city funded through European, national and local funding and

investment. Triangulum[54] is one of their major projects, a European-funded Horizon 2020 Smart Cities and Communities Lighthouse project that aims to transform the Manchester Corridor into a smart city district.

The Manchester Partnership of public, private and third sector organisations is tasked with delivering the Community Strategy,[55] based on a new ten year city vision around '*growth*', '*reform*' and '*place*', and the role of smart technology. Manchester City Council identifies partnership working as a particular strength for their smart city work. '*The level of collaboration between public, private, academic and the third sector is really strong and powerful and stimulating transformational change*'. They recognise that no individual sector has all the requisite skills to develop the smart city and the Council is increasingly an enabler in the process, bringing organisations together. They also work with several European city partners, the

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[53] http://www.manchester.gov.uk/smartercity

[54] http://www.triangulum-project.eu/
[55] http://www.manchesterpartnership.org.uk/mancheste rpartnership/site/index.php

EU-China Smart Cities Forum[56] as well as the UK Core cities[57],

3.3.2. Approach to evaluation

Manchester City Council is developing an evaluation framework for their Triangulum project with the University of Manchester taking a leading role in its development together with project partners. This involves the development of an Impact Assessment Framework as part of the 5-year evaluation and monitoring work package. It includes stakeholder mapping '*to identify who are the key people who need to be involved in the impact assessment. Already we've got a very rich student population in the corridor 72,000 potential population of citizens to involve that are digitally literate*'.

The Council have not yet developed a fully co-ordinated evaluation programme across all their smart city projects. Data is collected on a project-by-project basis to support different city strategies, for example, climate change, economic development, and transport strategies. Smart data sources were therefore contributing through strategic city mechanisms rather than being collected to inform evaluation of a specific smart city strategy directly, although they may decide to pull all the data into one place with the new community strategy framework being developed.

Manchester has been involved with the British Standards Institution (BSI) work on Smart City Standards[58]. They are also an active member of EUROCITIES[59], a network of over 140 major European Cities, where they chaired the Smart City Forum [60]. The group is '*looking at a*

selection of smart city projects, what worked for them and what has not with a view to informing the European Commission (EC) of the sort of things cities want to be seeing in new programmes, and what outcomes they would like to see. It will be a high level evaluation but this is the first attempt by cities jointly led by cities to do this evaluation.'

Manchester are represented on the Advisory Board of the European-funded EUROCITIES CITYKeys project[61] which aims 'to *develop and validate, with the aid of cities, key performance indicators and data collection procedures for common and transparent monitoring, as well as the comparability of smart city solutions across European cities*'. They have also done interesting benchmarking work comparing Manchester with cities across smart city areas, including economic development, governance, city infrastructure, transport, energy and citizen engagement.

Manchester City Council have been involved with the BSI work on the development of Smart City Standards[62]. However, the main influence on Manchester's evaluation approach has been the EC who they say '*now put a lot of emphasis on evaluation in European funding as they thought it was not strong enough in previous programmes*'. Until recently the focus of many funding bodies, such as Innovate UK has been on smart city development than rather than evaluation, although that is changing.

3.3.3. Effectiveness of evaluation approach

Manchester increasingly recognise the importance of evaluation and they hope to scale the Impact Assessment Framework, being developed in the Triangulum project to the city scale. '*Triangulum is providing the basis to get the Framework right, dealing with energy, transport, dealing with people; it's got*

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[56] http://eu-chinasmartcities.eu/
[57] The Core Cities group seeks to establish core themes around UK city policies and brings together the largest UK cities outside London, including Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield. http://www.corecities.com/
[58] http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/
[59] http://www.eurocities.eu/
[60] http://www.eurocities.eu/eurocities/forums/knowledge-society&tpl=home
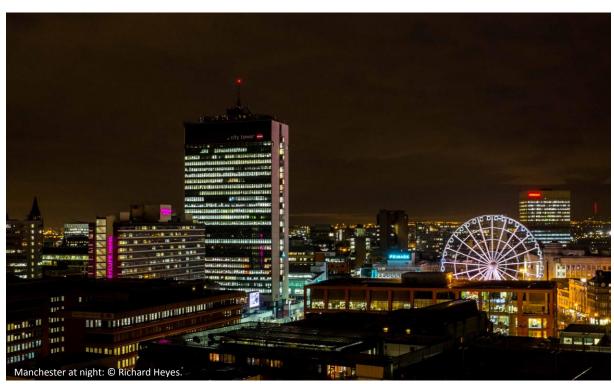
[61] http://www.citykeys-project.eu/
[62] http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/

the basic ingredients of the impact framework. Once it's working well it can be expanded in scale, geographically and thematically'.

However, the whole area of evaluation of smart cities is in its early stage and their experience is that '*there is no strong external pressure for any evaluation apart from the funder's requirements'*. There is concern that '*inappropriate evaluation could kill a good idea if conducted too early'*. Moreover, they '*don't think anyone can claim to have full evaluation programme going yet. There are questions about whether top-down approach is best, smart cities projects being innovation projects'*.

performance reporting framework which includes a Community Strategy Performance Dashboard[63] and Annual State of The City indicators. They have seen that '*a number of cities are developing dashboards for reporting on smart cities, but question whether the data behind the dashboard is giving the full picture…. to say you can feed it all into a dashboard is questionable. It's the trendy thing to do'*. Smart city dashboards '*need to be well thought through for reporting on smart cities to be of real value'*.

Their smart cities work is starting to contribute to decision-making in the city, for example '*airport city, with huge investment around the airport with a view to becoming a digital and physical infrastructure…has*

Manchester at night: © Richard Heyes.

3.3.4. Reporting on city outcomes and contribution to decision-making

Manchester primarily report on their smart city projects to their funders, and data is collated on a project-by-project basis supporting reporting on some city strategies. Manchester City Council use political structures to report more widely, although currently their smart city programme as a whole does not feed into their city

occurred directly as a result of work on smart cities'. There is the hope that '*Triangulum will be a game changer'* because it is scalable and they were also '*developing a digital infrastructure map for Greater Manchester area which is mapping transport, energy, utilities infrastructure in a digital format*

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[63]http://www.manchester.gov.uk/manchesterpartnership/downloads/file/313/community_strategy_dashboard_q4_1314

across the city which will enable us to understand what has worked' with regard to smart city solutions.

3.3.5. Challenges and improvements

A major challenge they face in smart city reporting and evaluation is that the funders '*all have their own criteria which makes it tougher because they have got a completely different set of criteria*'. They said '*you need interoperability across the criteria used for reporting*'. This is also an issue for developing a scalable standard Impact Assessment Framework, which they recognise is needed to support a co-ordinated approach to the evaluation of smart city projects.

They are working to support improvements through leadership and partnership with the EUROCITIES Smart City Forum and CITYKeys initiative. In addition, Manchester chairs the UK Future Cities group of the Core Cities[64], a group seeking to establish core themes around UK policies for cities across economic performance and as places to live, work, visit and do business which includes smart cities and evaluation, so that '*the cities could have a single conversation in relationship with government around challenges and opportunities with smart cities*'.

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[64] The Core Cities group brings together the ten largest UK cities outside London. http://www.corecities.com/

3.4. Milton Keynes

3.4.1. Smart city strategy and action

Milton Keynes in South East England has a population of around 260,000. The local government body with responsibility for the Borough of Milton Keynes (MK) is Milton Keynes Council, a Unitary Authority covering an area of 309 km^2.

The Milton Keynes Future City Programme is led by the Council and has a range of smart city projects and programmes. The aims are focussed on enabling the growth of the city, addressing infrastructure challenges and pressures, allowing for business growth, improving citizens' lives and growing the reputation and profile of the city. The programme is designed around collaborations between business, universities and government partners, including four of the national Catapult innovation centres[65].

One of the city's flagship programme is MK:Smart[66], a collaborative smart initiative between The Open University (OU), MK Council, British Telecom (BT) and other

partners from higher education, government and industry which is developing innovative solutions to support the economic growth of Milton Keynes and receives significant funding by the Higher Education Funding Council (HEFCE). Central to the project is the state-of-the-art 'MK Data Hub' which draws together information relevant to how the city functions, including data from key energy, transport and water infrastructure, sensor networks, satellite data and social media. The project also has innovation projects in the areas of transport, energy, water, enterprise, citizen engagement and education.

MK Council's Future City Programme includes other projects such as a citywide Internet of Things network[67] demonstrator working with BT, The OU and the Digital and Future Cities Catapults, which have funded the project. Milton Keynes also has several smart and low carbon mobility projects including the LUTZ Pathfinder project, which is carrying out the UK's first research trials of self-driving vehicles in pedestrianised areas, led by the Transport

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[65] https://www.catapult.org.uk/
[66] http://www.mksmart.org/

[67]http://futurecities.catapult.org.uk/project/milton-keynes-iot-demonstrator/

Systems Catapult[68] and funded by the UK Automotive Council and the UK government BIS Department. Moreover, the UK Autodrive project[69] in Milton Keynes received significant funding from Innovate UK to trial self-drive vehicles on public roads and footpaths, and trial service models for on-demand autonomous vehicles from manufacturers, led by the Arup Group with partners, including Ford Motor Company, Jaguar Land Rover, Tata Motors, Milton Keynes Council, Coventry Council, European Technical Centre, RDM Group, MIRA, Oxbotica, AXA, the Transport Systems Catapult, University of Oxford, University of Cambridge, The Open University and other organisations.

3.4.2. Approach to evaluation

Most of Milton Keynes' smart city work is externally funded so each major project has reporting requirements set by the funding bodies. '*For example with MK:Smart there are regular reports and reviews including an annual report to HEFCE. That includes not just the provision of data but also meetings, reviews, and presentations to allow us to convey the progress – qualitative and quantitative'*. In most projects, the partners collate the data for the evaluation process and this is then given to the funding bodies. In the case of MK:Smart, reporting is led by The OU which co-ordinates the response to the funder's External Panel '*challenge process'*.

Some of Milton Keynes' smart city projects have Key Performance Indicators (KPIs) although other '*projects are in the early stage of evolution and it seems enough to the funders to have an active project which is demonstrating innovation and being seen to deliver something interesting'*. The Council recognise that developing measurable indicators for progress in smart city projects is much easier than measuring their impact on city outcomes. '*Most of the smart service models and applications are not far enough advanced to be able to demonstrate implementation at scale, addressing real life challenges'*.

Although Milton Keynes does not yet have a framework for tracking the progress of the Future City Programme outcomes as a whole, the local authorities mentioned that '*MK:Smart is probably bigger than most cities' overall smart city projects and within it there are lots of measures like economic indicators etc. That may be as close as there is in the UK to a hard framework for evaluation, although that in itself is pretty flawed as a real tool. It is constructed to talk to a certain audience for a particular requirement. But the notion that tracking the extent to which smart city projects have enabled economic and housing growth of a city and drawing the linkages between the two is difficult – although this is a challenge more generally in assessing impacts on complex city issues beyond smart city programmes alone. We have done our best but it's pretty difficult to show the causal link and relationship'*.

MK Council already collect a lot of city data such as carbon emissions and transport data, and consequently did not think they would necessarily need to collate more data for their smart city evaluation work. However, they believed it would be important to get organisations working together to share data, breaking down the silos, and addressing barriers such as data ownership, bureaucracy and governance issues.

3.4.3. Effectiveness of evaluation approach

Milton Keynes Council's approach to smart city evaluation is mainly driven by funding bodies. Like many cities they identify the difficulty of proving the casual link between projects and city outcomes. They think evaluation works much better at the project level where you can see '*actual practical examples of things working - more qualitative*
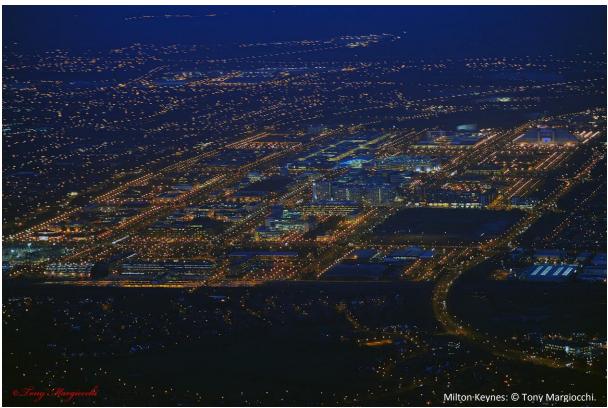
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[68] https://ts.catapult.org.uk/pods
[69] http://www.milton-keynes.gov.uk/pressreleases/2014/dec/reinventing-the-wheel-milton-keynes-establishes-itself-as-a-global-leader-for-smart-mobility

and sharing' approaches. The Council said many of their smart city projects have fluid boundaries as they are innovation projects. '*In terms of what they hope to deliver like service efficiency or business value, they are typically a long way from implementation and showing those benefits. While strategic approaches are required - setting outcomes you want to achieve and measuring whether you are - there are challenges with it. I think you can apply parts of this…but it needs to be flexible*

Milton Keynes: © Tony Margiocchi.

and make sure you are adapting to the circumstances of where you are. It would be the kiss of death for some innovation initiatives if you evaluated at the end of 12 months and it was not delivering the outcomes you set in the objectives'.

MK Council are aware of smart city evaluation approaches being developed such as the British Standards Institution (BSI) smart city standards[70]. However, they are particularly

interested in approaches that help cities assess '*what is possible and what the opportunities are and how to know whether you are exploiting these'*. The Council does not currently benchmark Milton Keynes against other cities, with the exception of some high level outcomes such as carbon emissions, although they would prefer a focus on information sharing across cities rather than comparing cities performance '*so that you understand the possibilities and potential rather than what is better or worse'*.

3.4.4. Reporting on city outcomes and contribution to decision-making

Milton Keynes report on their smart city work in the format required by funders who are '*particularly interested in whether we are spending the money and hitting outputs we said we would achieve'*. MK Council are interested in how smart initiatives are contributing to the city's objectives, and how they contribute to Milton Keynes's profile and reputation in being recognised as a world-class smart city although they do not currently measure this. They have KPIs for the Council Plan that are focussed on achieving city's

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[70] BSI have created a set of smart city standards and publications that respond to the emerging needs of the smart cities sector http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/

objectives, although these KPIs are not directly linked to their smart city work.

Led by the Director of Strategy in the Council, the smart city work is not subject to a formal reporting process in the Council, instead it tends to happen at the project or programme board level unless it involves a significant commitment of staff resource. The Council has set up mechanisms to support agility, speed and opportunism with their smart city development work as they said '*there are all kinds of applications and opportunities, it is difficult to anticipate.*'

3.4.5. Challenges and improvements

The key challenges identified by Milton Keynes Council for smart city evaluation is the need to avoid premature judgement and to allow time for promising innovation projects to mature before they are evaluated, and also the limitations associated with the lack of a good framework for evaluation. Demonstrations of smart city solutions may

be sufficient in the early development stages. What they would like to address is '*having a clearer sense across the board of the potential of different approaches and technologies*'. There is therefore interest in a framework that would allow them to evaluate their programme, and to identify if there are gaps in the smart city work and how this can be addressed.

MK Council also recognise that there may be a need to establish an overall reporting mechanism to city stakeholders, such as an annual report. They said '*many of the projects are funded outside of the Council …and most projects are not yet at a stage of full implementation and so are not expected to have significant community impact yet*'. MK Council are working on a roadmap for their Future City Programme, and this is a good time to review their approach to evaluation.

3.5. Peterborough

3.5.1. Smart city strategy and action

Peterborough is a city with a population of around 190,500 located in the East of England. Peterborough City Council is the local government body with responsibility for city governance, a Unitary Authority covering an area of 343 km[2].

Peterborough's Smart City work has developed through Peterborough DNA[71], a programme that received funding in 2013 from the Innovate UK Future Cities Demonstrator competition. Peterborough City Council specifically mentioned that citizens are a key element of their partnership approach. The city's smart city vision is people-focussed *'our approach in Peterborough has not been to invest in a huge amount of technology but to create projects that start to move our citizens along a way they can become smarter themselves'* and has a strong link to their environment work. Peterborough DNA aims to address city challenges in four key areas:

- 'Skills for our future' – ensuring the city has the skills and local talent to take advantage of emerging green markets and respond to sustainability challenges. It is one of the largest UK cities without a university, so they want raise academic aspiration and retain skills.
- 'Innovation' – identifying and solving city challenges, encouraging citizen innovation and entrepreneurial activity in the city, driven through the schools, BrainWaves Innovation Portal[72], Future Business Centre, Innovation Hub and Ecoinnovation Centre.
- 'Open data' – making city data more accessible and visual in order to better understand Peterborough through a living data portal[73] and working towards an urban observatory[74].

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[71] http://www.peterboroughdna.com/

[72] http://www.brainwaveinnovations.co.uk/
[73] http://www.brainwaveinnovations.co.uk/upload/cmspage/peterborough-dna/10-09-14_11-58-35_peterborough_dna_online.pdf
[74] http://www.peterboroughdna.com/urban-observatory/

- 'Smart Business' – helping local business engage with the sharing economy, sustainability and digital connection through the 'Smart Fengate' platform.

Peterborough DNA is led and delivered by Peterborough City Council and Opportunity Peterborough[75], the city's Economic Development Company owned by the Council. Around 30 city stakeholders from across the city were brought together to develop Peterborough DNA. Although Peterborough does not currently have a formal Smart City Strategy, they are having discussions around whether to develop a strategy for smart city development.

Peterborough City is a member of the European Innovation Partnership on Smart Cities and Communities (EIP-SCC)[76] and participates in a number of network clusters, in particular the Small Giants initiative which they mentioned '*aims to give small and medium cities across the EU a voice and a strong presence on the smart agenda scene*'[77] which is currently dominated by big cities.

3.5.2. Approach to evaluation

When Peterborough embarked on the Peterborough DNA challenge-driven interventions there was no clear requirement from the funder Innovate UK to evaluate the impact of the programme. It was noted '*the programme is in a development stage at the moment. It's a demonstrator really ....*' Their approach to evaluation is still very much in the initial stages of development. However, they have begun to think about impact assessment, and have conducted some initial evaluation to improve the programme, reduce the complexity of projects and address the scalability of projects. Their work is of great interest to their funders because they are a smaller-sized city. Their view was '*We are not*

big but if you can make something work in Peterborough then it is much easier to scale it up to a solution that can work in a bigger city'.

A lot of the data emerging from their projects is qualitative in nature, although some existing quantitative data is also collated, such as via the Living Data portal and their smart environment programme. They are working on developing smart tools to enable data collection that would help the Council to make appropriate interventions and recommendations, for example with local businesses. This and other community-sourced data is analysed by the Council's Central Intelligence Unit, and this is open data by default available to support evaluation.

Peterborough City Council identified the British Standards Institution (BSI) as an influence on their approach to evaluation. '*One of the big pieces of work that we are doing around evaluation is a new programme that we are developing in smart city leadership*'. It is part-funded by BSI and aimed '*at getting the leaders together in the city and looking at the challenges that we face, and where we want to go from a smart perspective*'. They have also been involved in the development of the BSI Smart City Standards[78], which addresses activities of benefits mapping, tracking and baselining, noting '*this allowed us to look at what we are doing and assess our work quite differently*'.

3.5.3. Effectiveness of evaluation approach

Although Peterborough City Council has yet to evaluate their programme, they identified the need '*to have more of a formulated framework that we can assess against, but we also recognise that it will continue to evolve as well, because as we learn more, get more involved and have more access to more data, that influences what we do. We understand that it won't be set in stone*'.

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[75] http://www.opportunitypeterborough.co.uk/about-opportunity-peterborough/
[76] http://ec.europa.eu/eip/smartcities/
[77] http://www.peterboroughdna.com/peterborough-dna---a-small-giant/

[78] http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/

Going forward with Phase 2 of their Future City Programme, they plan to focus on city challenges, and map the key metrics and data sources available to be used in assessments of particular impacts. Much of the work requires assessing the impact on people's lives as their focus is citizen-centred. They also plan to '*embed assessment into what we are doing so we can collect data and analyse as we go, rather than trying to quickly evaluate at the end of the programme*'.

Improvement through partnership is key to their evaluation work, and they noted '*we are doing some great stuff but we always strive to do better*'.

topic real for people and working out how they can embed it into other areas of council work.

Peterborough DNA has a Governance Board, which includes the Council's Chief Executive and Directors and a delivery team including key council officers and a cabinet member. It contributes to the higher level Greater Cambridge and Greater Peterborough Enterprise Partnership. Peterborough City Council also have a City Leadership Forum and organised a Smart City Leadership Event in 2015 as part of Peterborough DNA, to which they invited a number of public and private sector representatives. They say they have a

Peterborough: © Nick Lewis,NL photography.

3.5.4. Reporting on city outcomes and contribution to decision-making

City performance in Peterborough is reported in various ways including through reports produced by the Council although they did not yet measure outcomes from their Peterborough DNA programme. It was recognised that a future or smart city agenda, '*can be very difficult for people to understand - smart city, this is all jargon, too complex in my world*'. So they spend time making the

long way to go, although that the '*Smart City Leadership course was quite a big step forward – looking at how the work influences other stuff that happens in other performance areas*'.

There is informal reporting on Peterborough DNA work through public forums. The Council observed that '*It is all a form of reporting. Sharing experiences with others and being as honest as we can. It can be difficult from*

political perspective to say that something didn't work out as you expected it to. It is not always easy to share information but we do as much as we can'.

3.5.5. Challenges and improvements

A key evaluation challenge for Peterborough Council is a '*case of demonstrating individual projects and seeing what works and a lot of that isn't the sort of thing that can be easily measured and quantified'*.

Whilst evaluation has not been the main focus of Peterborough DNA to date, there is work underway to develop an evaluation framework through a partnership approach.

Peterborough City Council noted '*it is a very technical area. We are trying not to underestimate the complexity of it by thinking we can do everything ourselves'*. They were very focussed on learning from others and using this to develop their programme and evaluation work further. '*We work with different organisations and we are up for working with and learning from whoever can help us. We are not here saying we have all the answers because we never will have, things will always change, we need to continually keep ourselves up-to-speed, talk to the best people in the fields to make sure we are developing the best solutions for the city'*.

4. City approaches to evaluating smart city outcomes

The smart city case studies present a dynamic and varied impression of the cities' approaches to the evaluation of smart city activities.

4.1. Project-level evaluation

All the cities interviewed said their approach to smart city evaluation was currently focussed at a project level, primarily driven by their external funders' requirements. Evaluation requirements were varied: with funders such as the EC, requiring application of clear measurement indicators with Smart Cities and Communities Lighthouse projects[79] to support the obligatory data sharing across other European-funded projects; whereas the HEFCE funders of Milton Keynes MK:Smart programme[80] required regular reporting including qualitative and quantitative information to convey progress; and others such as Innovate UK funders of both Bristol[81] and Peterborough's[82] Future Cities Demonstrator projects, currently placed more importance on the cities' demonstration of innovation projects, although were beginning to address issues with evaluation.

Most of the cities were in the early maturity phases of smart city development as identified by IDC's benchmarking of cities against city maturity indicators (IDC, 2013), where demonstration of the validity of smart innovation solution concepts may be the most appropriate type of initial evaluation before projects can be scaled to the city scale. Several of the cities, including Milton Keynes, Manchester and Peterborough, were cautious of a premature evaluation, of what are often essentially innovation projects, fearing it

might kill off innovation opportunities arising from their smart city work.

The appropriateness of an evaluation approach is a key issue for evaluation (Arnold, 2004). Several cities, such as Birmingham, Bristol and Milton Keynes have established KPIs and measures for projects, although Birmingham was the only city interviewed with a formal Smart City Roadmap that was helping to establish actions and measures of progress towards smart city targets. The city authorities in Birmingham recognised the importance of establishing baselines for monitoring and measuring progress, and for identifying projects with the biggest city impacts and replication potential.

With reference to baseline measurement, most of the cities were influenced by the BSI Smart City Framework (SCF), which includes guidance on the articulation of smart city benefits, and their mapping, tracking and baselining against measures over time (BSI, 2014c). This included Peterborough City Council which intended to establish baseline measures from the outset with their Phase 2 plan for their Future City DNA programme.

4.2. City-level evaluation

Even with establishing baselines to monitor progress, several cities recognised the difficulty of proving the value of smart city activities, projects and interventions, and identifying the causal effects on targeted outcomes. Milton Keynes Council recognised that developing and measuring indicators of progress with their smart projects has been much easier than measuring the impacts on city outcomes. With their MK:Smart programme they attempted to develop a hard evaluation framework, although admitted it is difficult to show the cause-effect relationships in their smart city work. Birmingham city authorities also acknowledged difficulties trying to relate the inputs to outcomes and attributing causality to smart city activities,

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[79] http://ec.europa.eu/eip/smartcities/about-partnership/how-does-it-work/index_en.htm

[80] http://www.mksmart.org/

[81] http://www.peterboroughdna.com/

[82] https://connect.innovateuk.org/documents/3130726/6091879/Feasibility+Study+-+Bristol+City+Council.pdf/4269233f-cd8b-47da-9f0b-58a27294a684

even when the baseline measures reveal progress. This reflects evolutionary-systemic perspectives on the complex, dynamic, and evolving nature of city systems and subsystems that are not clearly bounded (Arnold, 2004). Several local authorities recognised that this complexity inevitably creates difficulties for the evaluation of innovation interventions, and proving the direct and indirect influences of smart city projects on city outcomes.

All the cities interviewed intended to undertake evaluation at the programme level, and several were working in partnerships, including with their local universities to address evaluation challenges. Digital Birmingham have already conducted research looking at various evaluation frameworks, models and standards; and had worked with Arup to trial an energy-focused smart city framework. The cities all mentioned their awareness of the BSI Smart City Framework (PAS181)[83], which provides guidance on principles and performance standards in programme implementation with reference to critical strategic and operational success factors (BSI, 2014c), of relevance to evaluation.

However, most councils said they had not adopted an effective evaluation framework yet, to measure the impact of their smart city work on wider city outcomes. Milton Keynes Council had developed many measures through their MK:Smart programme[84] which could contribute to a smart city evaluation framework, although they faced challenges in trying to measure the impact of specific projects on wider city outcomes. Both Milton Keynes Council and Manchester City Council regarded the evaluation of smart cities as being at an early stage and did not think any cities had established a full evaluation

programme yet. This was supported by Peterborough City Council which had conducted an initial evaluation to improve their Future City Programme, reduce the complexity of projects and address project scalability issues, and was beginning to consider their approach to impact assessment.

It was apparent that the EC has been placing an increasing emphasis on evaluation in EC-funded projects, and this has been strongly influencing cities' work to address smart city evaluation challenges. Both Birmingham and Manchester City Councils have been involved in the EC-funded CITYKeys[85] project working on the development of smart city KPIs and data collection procedures to enable the comparability of smart city solutions across European cities. Manchester City Council were also in the process of developing an Impact Assessment Framework in partnership with universities for one of their European-funded smart city projects Triangulum[86], which they hoped to scale up geographically and thematically to the city scale.

4.3. Effective evaluation

All the cities have started to look at potential evaluation frameworks for their smart city programmes, although there were questions about existing evaluation frameworks and how meaningful they were. Birmingham city authorities were aware of considerable work in this area and acknowledged that no accepted approach had emerged as yet. They had concerns that many smart city evaluation frameworks were based on an arbitrary selection of indicators, and focused on what is easily measurable, or became too specific about what a city had to achieve to become smart when they regarded smart cities as multi-faceted.

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[83] PAS181:2014, 'Smart city framework – Guide to establishing strategies for smart cities and communities' http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/
[84] http://www.mksmart.org/

[85] http://www.eurocities.eu/eurocities/projects/CITYKEYS-Smart-city-performance-measurement-system&tpl=home
[86] http://www.triangulum-project.eu/

In Birmingham there were concerns voiced that smart city benchmarking might become a popularity contest, when comparing cities like-for-like would not necessarily reflect the different challenges that individual cities faced. Instead benchmarking studies should help cities to identify gaps in their smart city work and get a clearer sense of opportunities.

Milton Keynes Council suggested that an effective evaluation framework approach should give cities an idea of the potential for different smart city approaches and technologies, so they could identify city strengths and weaknesses. Such an evaluation framework should have a built-in flexibility and be adaptable to specific city circumstances. Moreover, Peterborough City Council recognised that they needed to have a more formulated measurement framework embedded in their smart city work that would be capable of evolution in response to new data collected as their work develops. Moves towards addressing the design specification for a smart city evaluation framework would be informed by the high level evaluation work of the EUROCITIES Smart City Forum[87] led by Manchester City Council, which is examining the effectiveness of smart city projects and their city outcomes that would inform new EC-funded smart city programmes.

4.4. City impacts of smart city work

Questions were raised about whether a specific smart city evaluation framework is needed when city councils were typically more concerned with measuring strategic city outcomes associated with the statutory obligations of cities. City councils including Birmingham, Bristol and Manchester mentioned that they are already obliged to measure a large number of KPIs against their city strategies and actions. Whilst some city strategies, council plans and actions are statutory documents, at present city councils have no obligation to have a smart city

strategy or roadmap, or to evaluate this outside the requirements of externally-funded programmes. At a time when cities such as Bristol, were trying to reduce the number of city KPIs measured against their city strategies, some cities were considering whether it is valuable to establish additional specific smart KPIs for measuring smart city programmes. Bristol City Council's preference was to evaluate the contribution of smart city technologies to the existing city KPIs associated with strategic city outcomes, rather than to establish extra smart city KPIs.

At the same time, the cities recognised they faced challenges to align their smart city activities with wider city strategies and measure the impacts on city outcomes. Bristol City Council mentioned the need to align their smart city activities with strategies such as the Mayor's Vision for Bristol,[88] and to demonstrate how their smart city work impacts on city outcomes. In Birmingham, the city authorities were interested in the evaluation of the collective impacts of city projects to inform city outcomes, and planned to ensure that their smart city demonstrator projects have direct measurable city impacts, for example on city health and employment outcomes. Peterborough similarly planned to focus on their city challenges, and map the key metrics and data sources available for use to assess impacts linked to specific city strategies.

4.5. Data intelligence for smart city evaluation

The cities were establishing mechanisms for collecting and sharing data through their development as smart cities to support their city strategies. In Birmingham, the city authorities have started to explore how data intelligence works across their city, bringing together datasets as part of their smart city approach and encouraging data sharing with other organisations. Peterborough City

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[87] http://www.eurocities.eu/eurocities/forums/knowledge-society&tpl=home

[88] https://www.bristol.gov.uk/mayor/a-vision-for-bristol

Council has also established mechanisms for feeding data collected through their city projects to the Council's Central Intelligence Unit.

The value of data intelligence is being recognised for smart city development. Bristol City Council identified the importance of opening up data generated and collected through the Bristol Open Data Portal to unlock new city opportunities. In Milton Keynes, local authorities mentioned that the city already had significant volumes of real-time data streams and static datasets collected through the MK:Data Hub, and their focus was on enabling organisations to share data, and addressing barriers such as data ownership, bureaucracy and governance issues.

Increasingly cities have obligations to share data across smart city projects, often imposed as a condition of funding, for example on EC-funded Smart Cities and Communities programmes[89], to support both data sharing and intercity benchmarking studies. BSI's work on PAS182 '*Smart city concept model – Guide to establishing a model for data interoperability'*; provides a framework for smart cities to normalise and classify data from many sources[90] (BSI, 2014d), supporting standardised data-sharing.

City data generation and collection mechanisms and data hubs are helping develop data intelligence and beginning to inform city strategies and evaluation. For example, Bristol City Council have projects using real-time traffic data collected through the Traffic Control Centre to measure congestion in the city, combined with other data collected through the Bristol Open Data Portal.

Several of the councils interviewed mentioned how their smart city work could contribute data intelligence to address the evaluation of specific city challenges and strategies. For example, Manchester City Council mentioned that the data collected through their smart city work has been informing city strategies, such as climate change, economic development and transport strategies. Hence, the potential for data-intelligence driven evaluation is beginning to be realised.

However, Bristol City Council stressed that smart cities is less about cities being digital, and more about cities being liveable and achieving quality of life outcomes for citizens. Both Peterborough and Bristol City Councils were interested in collecting both quantitative and qualitative data to measure the impact of smart city initiatives, particularly to evaluate outcomes for their citizens. A key challenge for cities is the effective use of city data intelligence to drive evaluation of their smart city work.

[89] http://ec.europa.eu/eip/smartcities/about-partnership/how-does-it-work/index_en.htm
[90] http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/PAS-182-smart-cities-data-concept-model/

5. City Reporting on Smart City Outcomes

All the cities interviewed have established processes for reporting on city performance related to measuring progress on city objectives which are set out in the Community Strategies, or the city's Council Plan or Corporate Plans, led by the relevant Local Authority. The larger cities including Birmingham, Bristol and Manchester also publish Annual State of the City Reports. The cities acknowledged that their smart city programmes did not currently feed directly into their city performance reporting process, and therefore were not subject to a formal political reporting process. In Birmingham, the city authorities had an additional reporting process to their Smart City Commission, with quarterly reports.

Councils typically report on hundreds of KPIs as part of their city performance reporting, and many of the indicators reported have links to their smart city work i.e. energy, climate change, transport, waste and the liveability of the city. Bristol City Council considered that adding a new suite of smart city KPIs to their city reporting process would not be helpful as there were moves to reduce an apparently burdensome number of KPIs. Instead what was needed was a mechanism to report how the smart city programme was contributing to the existing city KPI's.

5.1. Forms of reporting

Whilst the cities had established reporting mechanisms for the individual projects and programmes, most of the reporting on smart city work has been driven by funding bodies.

An additional form of smart city reporting is through city performance dashboards that a number of cities had developed, including Manchester. Whilst this can be helpful, Manchester City Council questioned whether the data behind the dashboard can give the full picture, and they mentioned the importance of getting the design of smart city dashboards right to create value for city

authorities. Rather than over-focusing on city data, dashboards and performance, several cities including Manchester and Bristol, preferred to focus more on information, narrative and vision, in their thinking about smart cities as liveable rather than digital cities.

Several cities mentioned the importance of informal reporting on their smart city work through public forums, including Peterborough City Council, which regarded sharing experiences as a very important part of their smart city work. Bristol City Council also had a track record of reporting to city stakeholders through open stakeholder meetings and annual reviews through their digital partnership. However, as their smart city programme has grown they have had less time to do this important public engagement work. Both Bristol and Peterborough City Councils thought it important to have a forum where people can share ideas, criticism and progress.

Milton Keynes Council also recognised the need to establish a reporting mechanism to city stakeholders and politicians, which could take the form of an annual report to report on the overall outcomes of their Future City Programme. Cities were interested in appropriate reporting structures that engage and empower stakeholders and citizens with their smart city work, through informal and formal reporting mechanisms, as well as supporting city learning across smart cities.

5.2. Contribution to city decisions

The councils interviewed all agreed that their smart city programmes were beginning to have some influence on decision-making in their city, particularly on city investment decisions. Manchester City Council had influenced smart development work around their airport, and they also held the view that

their European project Triangulum[91] would have a significant influence on the city. Bristol City Council had recently established the Bristol Energy Company[92], intended to be *'smart from the start'* which had emerged from their smart city energy projects. In Peterborough, the City Council had recently led a Smart City Leadership event for public and private sector organisations, exploring how their smart city work influences other areas of city performance, which they believed had helped to make the smart city agenda real for people working in the city. Developing more rigorous evaluation and reporting mechanisms would support city decision making around city development and investment.

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[91] http://www.triangulum-project.eu/
[92] https://bristol-energy.co.uk/

6. Smart City Evaluation and Reporting Challenges

The key challenges for smart city evaluation identified by the cities interviewed centred on how to measure the impacts of programmes and projects on wider city outcomes, such as improving transport, increasing employment, improving citizens' quality of life or reducing carbon emissions. The cities already have a significant amount of data at the project level, although faced challenges of making sense of the data, and deciding which methodology to use to measure the impact of their smart city work on city outcomes. Key reporting issues for the cities interviewed were around establishing appropriate reporting structures, so that their smart city work is embedded in city management structures to support communications about the value of their programmes and activities.

6.1. Smart city evaluation challenges

Some of the cities had established approaches to measuring the progress of their smart city projects against baseline measures and targets using a selection of KPIs and quantitative or qualitative measures. However, there was currently no accepted methodology for city evaluation of smart city work and measurement of city impacts that would inform city policies, strategies and future investment decisions. There were questions about whether an overarching smart city measurement framework is needed to measure the impacts of smart city work, and whether additional specific smart KPIs need to be applied to measure impacts, or whether a better approach is to measure the beneficial impacts against existing city KPIs aligned with city strategies.

However, an accompanying evaluation of smart city work is still needed to prove the value and impact of a smart city programme intervention on city outcomes. A measurement-focused approach alone could not address the complexity of dynamic, evolving and unbounded city systems and

subsystems (see Arnold, 2004), and therefore could not prove that improvements in city outcomes were attributable to specific smart city programmes, projects and activities.

Most of the cities were aware of the BSI Smart City Framework (PAS181)[93] that provides guidance on programme implementation and standards with reference to critical strategic and operational success factors, and also includes recommendations for supporting the mapping, tracking and baselining of smart city benefits (BSI, 2014c); and the European-funded CITYKeys[94] project, which supports the comparability of smart city solutions across European cities.

Few cities mentioned their awareness of existing work to develop smart city indicator frameworks supporting evaluation in this area, such as the European Smart Cities Ranking Model (Giffinger et al., 2007), and the Smart City Index Master Indicators (Smart Cities Council, 2014). However, in Birmingham questions were raised about whether such approaches were meaningful, when many selected smart city indicators seemed arbitrary and focused on what is measureable rather than what should be measured. Birmingham had already been involved in trials of an energy-focused smart city framework, and clearly trials could help develop meaningful and standardised indicator frameworks to support city evaluation and measurement.

An issue for cities is that they are measured and ranked by external smart city indicator frameworks, and also on city indexes such as *The Networked Society City Index*[95] (Ericsson Ltd, 2014), and the *Cities of Opportunity*

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[93] PAS181:2014, 'Smart city framework – Guide to establishing strategies for smart cities and communities' http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/
[94] http://www.eurocities.eu/eurocities/projects/CITYKEYS-Smart-city-performance-measurement-system&tpl=home
[95] http://www.ericsson.com/res/docs/2014/networked-society-city-index-2014.pdf

Index[96] (PwC/Partnership NYC, 2014), which are used to compare and rank cities' performance. Whilst some councils were not keen on city league tables or popularity contests, several were interested in their (relatively high) city ranking on global and European indexes and keen to develop their reputation and profile as world class cities.

The main aim of evaluation is to demonstrate the value of a city intervention. The EIP-SCC recommend that a smart city evaluation system framework should: address the strategic and political and operational levels; establish measurement over time based mainly on real-time data; be evidenced against baselines and strategic targets; support cities' evaluation of their progress towards becoming smart cities through city benchmarking and inter-city comparisons; develop through a stakeholder process that engages relevant research and community stakeholder groups, whilst being open to improvement and the integration of future innovations; build on existing urban development indicator systems and be aligned with typologies of European cities (EIP-SCC, 2013).

These recommendations for developing a smart city evaluation framework resonate with the views of a number of city authorities, that an evaluation methodology should be: flexible and adaptable enough to reflect different, complex city challenges and circumstances; cover meaningful city indicators with both qualitative and quantitative measures rather than having a narrow focus on smartness; and be open to improvement and evolution in response to new city mechanisms for data generation, collection and analysis. Evolutionary-systemic perspectives on the evaluation of innovation systems in Science and Technology Studies can also inform better approaches to evaluation (Arnold, 2004; Edler et al., 2012),

and support an evaluation of evaluations, combining evaluations to provide high level evaluations of city policies and strategies (Magro & Wilson, 2013).

Smart technologies are creating new opportunities for data-intelligence driven evaluation, encompassing real-time and static data sources with urban analytics, to support the development of best practices in evaluation and reporting. Cities are exploring the value of data intelligence to support city strategies, and beginning to consider the best use of smart technological sources of data intelligence for evaluation of smart city work.

6.2. Smart city reporting challenges

A key challenge for cities is how to report effectively on the results of their smart city work, and its impact on city outcomes. Establishing appropriate reporting structures is important, so that smart city work is embedded in city management structures. Moreover, some city authorities recommend that reporting should be conducted through the wider community organisations responsible for delivery and outcomes of Community Strategies and Council/Corporate Plans, embracing a partnership of city authorities, local bodies and stakeholder interest groups including universities, health service, and business and voluntary sector organisations and citizens. For example, in Birmingham the city authorities recommend there should be a mechanism for reporting through the management structures of all organisations responsible for city outcomes, embracing the wider partnerships and community, so that all city stakeholders understand the contribution of the city's smart city work. This would support the development, evaluation and reporting of city strategies and policies, and decisions about future investments.

A key reporting issue is how to make good use of data intelligence to communicate the value of smart city work generally. The lack of standardisation and interoperability in the

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[96] http://www.pwc.com/us/en/cities-of-opportunity/2014/pdf-download.jhtml

reporting criteria used was identified as a reporting challenge for cities. Manchester City Council observed that external funders all have their own criteria for reporting smart city work, which can be very different and there is therefore a need for greater interoperability across reporting criteria.

In Birmingham, the city authorities suggested that a standardised mechanism for reporting data across sectors would help with smart city evaluation. This is also an issue for Manchester developing a scalable standard Impact Assessment Framework to support a co-ordinated approach to their evaluation of smart city projects.

Integrated reporting methods can contribute to holistic reporting and analysis of the value, benefits or '*stock of capitals*' being created and developed by smart city programmes through a process of integrating measures with connected information flows (IIRC, 2013), of relevance to reporting on the strategic delivery of smart city benefits (See BSI, 2014c).

6.3. Moving forward

The findings provide a series of contemporary smart city case studies of Birmingham, Bristol, Manchester, Milton Keynes and Peterborough that exemplify city approaches to the evaluation and reporting of smart city projects and programmes. Moving forward, the findings show the cities were examining how they can develop or use a smart city evaluation framework to measure the impact of their smart city work on wider city outcomes, and support effective communication and reporting of the value of the city work. Cities were also exploring the value of data intelligence and beginning to consider the opportunities afforded by smart technologies for data intelligence driving the evaluation and reporting of smart city work.

Smart city evaluation and reporting is clearly on the cities' agendas and city authorities were keen to learn from other cities. There was considerable interest in a range of

European and UK initiatives, such as the BSI Smart City Framework (PAS181)[97](BSI, 2014c); and the European-funded CITYKeys[98] project. Manchester City Council was also leading development of an Impact Assessment Framework for Manchester smart city projects which will be informed by their high level evaluation work through the EUROCITIES Smart City Forum[99], to examine the effectiveness of smart city projects and their impacts on cities.

It is also likely that the Small Giants network cluster[100] supported by Peterborough City Council as a member of EIP-SCC[101], will increasingly address evaluation issues. Manchester City Council also leads the Core Cities[102] Future Cities group which should provide a good opportunity for the largest cities outside of London, including Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield, to work together on developing approaches to smart city evaluation, and likely to have far reaching implications for UK smart cities.

In this context, the SmartDframe research led by The Open University through the MK:Smart programme[103] aims to support the work of city authorities, industry, academics, policy-makers across the UK, and to city discourse world-wide about best practice approaches to the evaluation and reporting of the impacts of smart city programmes on complex city systems and their benefits for cities.

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[97]PAS181:2014, 'Smart city framework – Guide to establishing strategies for smart cities and communities' http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/
[98]http://www.eurocities.eu/eurocities/projects/CITYKEYS-Smart-city-performance-measurement-system&tpl=home
[99]http://www.eurocities.eu/eurocities/forums/knowledge-society&tpl=home
[100]http://www.peterboroughdna.com/peterborough-dna---a-small-giant/
[101] http://ec.europa.eu/eip/smartcities/
[102] http://www.corecities.com/
[103] http://www.mksmart.org/

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