# Smart cities as a mechanism towards a broader understanding of infrastructure interdependencies

## 1. Introduction

Finding new approaches to overcome complex urban problems has always been of interest for policy makers and academics. While working in partnership has become increasingly crucial in urban management due to the fragmented nature of infrastructure services, these infrastructure networks increasing technical interconnectedness has provided opportunities for reshaping urban governance processes, enabling new sites of experimentation and stimulating sustainable and inclusive urban infrastructures. This paper asks the research question of whether smart cities can stimulate a joined-up thinking and facilitate interaction between a series of actors and technical systems. It argues that infrastructural interdependencies are not just about 'cities as technological assemblages' versus 'cities as sites of experimentation', but more attention for 'cities as sites of experimentation' can have emancipatory working upon different actors against whom the cities as "technological assemblages models" may exclude or discriminate.

In the UK, the existing organisation of infrastructure delivery (planning, design, construction and operation) between national governments, local authorities, private sector and non-governmental organisations results in fragmented, sectoral approach to infrastructure creation and management (Carhart et al., 2016). The distinct organisations (sometimes referred to as 'silos') in which infrastructure projects are procured and managed can create capacity limitations, inefficiencies and missed opportunities for collaboration. The UK's approach

infrastructure network development provides an example where various elements have been viewed in isolation, namely planning, design, construction and operation of infrastructure systems (Dawson and Walsh, 2015; HM Treasury, 2011). This suggests that these interdependencies can be considered as an opportunity to create new forms of urban governance which better exploit the complexities and diverse layers of infrastructure systems through which cities are connected.

The concept of 'smart city' has been introduced promising to use of ICT infrastructure, smart technologies and data to solve the unprecedented challenges in contemporary urban management for sustainable and social cities. The smart city concept not only points to the importance of exploration of modern technologies, but more importantly highlights the possibility of new kinds of joined-up approaches. It offers cities new solutions for providing public services, but also and arguably more importantly creating opportunities to support innovation and entrepreneurialism. This paper looks at examples of two Smart Cities, namely Bristol and Milton Keynes (MK), an examines in parallel the ways in which they have been spaces of technological assemblage and governance experimentation. The paper argues that three important factors emerge, namely ensuring collaboration, inclusion and the institutional capacity in the context of mobilising collective learning and transforming city infrastructure.

## 2. Urban infrastructure and smart city

Any discussion of contemporary sustainable urban and regional development need deal with questions of infrastructure. Scholars interests in exploring the reconfiguration of urban infrastructure systems build on a long-tradition of transition research and socio-technical

systems (Coutard, 1999; Monstadt, 2009; Moss, 2014). They highlight the importance of interaction between social and technical systems, and how urban actors and their practices encounter and change infrastructure in deployment. Having a long genealogy encompassing urban technology, sustainability and urban development (see Albino et al., 2015), applications of smart technologies and data emerged as a means of solving cities' unprecedented challenges such as rapid urbanisation, climate change and increased pressure on services such as transport, health and energy. But the increasing levels of risk, ageing infrastructure, financial concerns, and the missing "citizen" element required new kinds of understanding where all parties work together to deliver seamless "smart solutions" to overcome complex urban problems. This necessitates a holistic approach where smart city is considered in relation to the presence of diverse actors and their interactions within the city.

Recently, smart city discussions focused on the ways cities have been instrumented and governed based on experimentation (Glasmeier and Christopherson, 2015). On the one hand, scholars refer to the widespread implantation of sensors into urban and household environment in cities. Rabari and Storper (2015) argue that the application of new technologies would make it possible to manage urban infrastructure by facilitating deliberate communication and automated user data. Kitchin et al., (2015) refer to the instrumentation of the data underpinning projects. They raise the multiple, complex and independent natures of cities and question whether a collection of data would be the only way forward, representing a 'cities as technological assemblage' model.

Conversely, some scholars focused on new governance models comprising a series of actors and opens up new sites of experimentation and interactions through data platforms or data centres in cities. Rossi (2015) looks at various capital accumulation strategies associated with

the notion of smart city in Italy. He argues that the smart city discourse has been used to stimulate the innovative start-up firms and a new cultural economy contributions of which came through community practices. Drawing on Rio de Janeiro's Operations Centre, Goodspeed (2015) points at the importance of local diversity and the socio-political dimensions of cities. He identifies two general strategies for cities, namely the role of institutions and the IT enabled collaborative planning, for public sector innovation. These represent a 'cities as sites of experimentation model'.

While these discussions primarily took an explicitly urban scale of analysis, some studies considered how the smart city concept and the accompanying benefits and challenges have affected by a larger geographical scale. Carvalho (2015) argues that learning and societal embedding processes taking place in cities can influence other scales and places via the operations and changing strategies of globally oriented technology companies. Similarly, Herrschel (2013) refers to the term 'smart city regionalism' to talk about how different rationales, agreed principles and legitimacies of smart city polity can be combined in a collaborative, network-based approach at a regional scale. Both studies point out the role of the innovation networks and how smart cities can operate beyond the city boundaries. These three recent sets of arguments on smart cities, the application of new technology, new governance arenas, and smart city-regional spaces, demonstrate how increasing smart-city interconnectivity can provide opportunities for stimulating more inclusive forms of urban infrastructure.

## 3. City Experimentation via Smart City Technology

The empirical material draws on twenty semi-structured interviews undertaken between March and August 2016, recent policy documents and promotional materials. The interviewees were identified from publicly available documentation and they included people who were (and still are) involved in the smart city conversations in Bristol and MK. The distribution of the interviewees in each case is 4 academics, 3 policy makers and 3 people from NGOs in Bristol; and 5 policy makers, 2 academics, 2 people from NGOs and 1 person from a private company in MK. Participants were emailed in advance with a brief description of this research project and the interviews were arranged at a time that was convenient for the participants. The semi-structured interviews were used as they enabled two way conversations and provided more flexibility for the interviewer. The collected data was transcribed and analysed anonymously, and stored (for 20 years) according to the University of Bristol ethics guidelines. Bristol and MK were selected because of their visibility on the policy domain in relation to the smart city agenda in the UK, but also due to their strong links with other international cities across the world (particularly the Chinese cities via the EU-China Smartcities programme). In addition, Bristol and MK have been home to a number of projects run by the Future Cities Catapult, a UK Government supported centre for the advancement of smart cities since 2013.

In 2015, a series of initiatives and programmes was launched in Bristol to explore how a software defined network can facilitate learning for the future. 'Bristol Is Open' (BIO) was a city-wide experiment and a joint venture between Bristol City Council (BCC) and the University of Bristol, using big data to solve problems such as air pollution, traffic congestion and assisted living in Bristol and the wider city region. A 'City Operating Systems' was developed artificially by the University of Bristol to manage "machine to machine learning" across the city. This was intended to be based on small sensors', such as smart phones and

GSP devices, providing information about city life. The BIO initiative was enabled through the connection of three local host partners:

- At-Bristol: an educational charity and one of the UK's leading science and discovery centres using a series of multimedia techniques;
- Watershed: a cross-artform venue and producer specialising in producing, sharing, developing and showcasing exemplary cultural ideas and talent; and
- Engine Shed: a collaboration between BCC, University of Bristol and the West of England Local Enterprise Partnership to generate innovation through collaboration and networking.

MK:Smart was a collaborative smart city initiative in MK to leverage large-scale city data to sustain and accelerate economic growth. The Open University (OU) operated the MK:Smart project between January 2014 and December 2016 to explore how to manage water efficiency, energy usage and better transport to support the economic growth in the city region. A data hub, namely MK Data Hub, was created to support the collection of data across a variety of different sources, including local and national open data, infrastructure networks (energy, transport, and water), sensor networks and social media. The Hub was being run by the OU and British Telecom: similar to the software defined network approach that BIO has adopted, this application stimulates machine to machine interaction where one piece of software asks another programme to perform a service based on existing data. The key partners facilitating smart-city discussions in Milton Keynes were MK Council and the Knowledge Media Institute (a research arm of the OU), with the MK MK Data Hub remaining central to MK:Smart. The Hub focused on different infrastructure networks domains: energy, water and transport: energy related research was to be undertaken by the

OU, whilst the University of Cambridge was active in contributing to the transport related research. The water domain is split between Anglian Water and HR Wallingford.

While BIO and MK:Smart involved a series of actors involved in the projects, they both also sought to actively equally position citizen engagement as an important component of their approach. Bristol used a variety of initiatives in that respect. One striking example of this was the involvement of Knowle West Media Centre (KWMC), an arts organisations and charity, which remains one of the key organisations for community engagement. At the time of writing KWMC was running Bristol's Living Lab as a part of EnoLL, using that network to further understand the role of citizens and technology. Milton Keynes was likewise using Community Action MK, a non-profit organisation, as the key 'citizen engagement' body within MK:Smart. While at one level, Community Action MK was active in informing citizens, at another level, they explored how citizens can use the smart infrastructure in MK via an online platform "ourmk.org". Citizens were also informed about the projects through Citizen Labs which are workshops led by the OU. Although both cities were through their projects attempting to tap into national and international funding with their demonstrators, in the course of the study an increasing concern emerged regarding who should take part within such collaborations and who should lead the process. Moreover, it remained unclear who precisely should decide whose behaviour was to be changed, nor in whose interest that change is beneficial, as well as some of the more technical questions such as how knowledge gets translated into codes and algorithms within the machine to machine based interaction.

## 4. Smart Cities through the Lens of Integrated Infrastructure?

Both BIO and MK:Smart sought to integrate a series of different infrastructure domains. In the case of Bristol, BIO sought to bring together ICT, transport and energy whilst MK:Smart was active in facilitating conversations between transport, water and energy infrastructure. However, a series of challenges for these communications emerged in both projects. The first related to the complexities of integration: although the projects were able to facilitate cross-utility conversations in the city region, there was a degree of ambivalence within the long-term collaboration strategy as to whether the city actors were engaged in a full (associate) project partner role or merely informed. The biggest challenge of ensuring full collaboration was the availability of time and resources in the context of research projects with limited scope to thoroughly investigate the nuanced complex relationships between various infrastructure domains. These conversations also did not deal with technical complexities of integration, including who sees what, what that shared view looks like and who has sovereignty over outputs.

Another issue arising from the two case studies related to the question of inclusion, i.e. who is (or should be) involved in the smart city discussions. The smart city thinking is based on a presumption that one needs to have good, affordable, open communication networks. However, there are places in both cities where infrastructure was not in place or openly unavailable. This clearly impacts on the potential outreach of the smart city conversations. Although there was in both cases a recognition that the involvement of different actors can create positive impact, the current collaborations between city councils and universities seems rather exclusive. There are in both cases a number of community organisations around environmental and climate change issues that can provide input. But it was not clear that some organisations that might have had useful knowledge about infrastructure were not involved in thinking about the form and the organisation of the interactive infrastructure.

As a final observation, institutional capacity remains an important factor for the implementation of smart city projects. It has been argued that the application of path dependency to the development of the institutional capacity played an important role in smart city thinking. In both cases, what was possible within the smart-city projects was dependent on what had emerged around earlier programmes such as digital inclusion, the 'e-participation'. At the same time it also demanded that those leading these projects were familiar with the smart city language in the emergence of ubiquitous connectivity, new sensors and mobile computing. The remainder of the smart-city process was less about infrastructure and more about harnessing existing assets, i.e. citizens, businesses and infrastructure, and developing work routines that operated in a "smart way" to give partnership. Successful engagement was built upon two way conversations and relationships over time than a single set of consultations based on fixed questions at a single point in time. What was critical was in findings was to participate in making informed choices of the future and create individual benefits without requiring citizens to have detailed knowledge of the mechanics of the smart city. This participation requires a strong leadership and institutional commitment.

## 5. Conclusion

This paper has asked the research question of whether smart cities can stimulate a joined-up thinking and facilitate interaction between a series of actors and technical systems drawing on two UK smart city cases. Both BIO and MK: Smart sought to bring together a variety of actors and encourage collaboration amongst different stakeholders. A common understanding emerged in both projects that increasing participation added value to the project, but in

practice that could be difficult. Also both cases showed that smart city ideas did not emerge in a vacuum in either city: they built on a long history of digital inclusion or e-governance programmes which nurtured smart city conversations in Bristol and MK. This is an important point to mention when proposing the extension of smart city projects to other cities, regions and countries. More importantly, the case studies corroborated the importance of the interconnected nature of smart city as emerged in the literature analysis in Section 2.

One of the main challenges in this paper is that both BIO and MK: Smart were at the time of writing in their early development phases. Time will show whether these projects will capture the interests of local communities and respond to their needs. However, even though both programmes serve as a prelude to more democratic and participatory experimentation in cities, there has been a systematic neglect for an understanding of the interaction between social and technical systems. Both projects seemed to expect citizens to be willing to engage sincerely in these projects in order to contribute to someone else's project objectives. More experimentation and awareness of this social dimension appears important to realising the great potential for social smart-city infrastructures.

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