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Exploring participatory visions of smart transport in Milton Keynes

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This paper explores citizen concerns emerging in the design stage of MotionMap, a smart transport initiative developed in the context of a £16 million smart city programme. A city-wide sensing system integrated with other databases will provide real-time information about vehicular and pedestrian movement. The experience of a series of smart transport workshops in Milton Keynes suggests that citizens feel that they bear the cost of smart cities through potentially intrusive surveillance producing sacrifices in convenience and privacy, while the gains are captured by industrial and governmental actors. This distrust of surveillance through urban sensing systems is not inflexible. Such systems can gain legitimacy through a participatory approach where users legitimize the sensing system by taking an active role in providing transport data, as opposed to having it 'harvested' from them through passive or opportunistic mechanisms. Participatory approaches are challenging because users will engage only if the system can provide compelling benefits. A key contribution of this research comes from identifying that the benefits important to citizens are not necessarily measured in economic terms nor in terms of increased efficiency.

1. Introduction: smart cities, sensing and society

This paper explores citizen responses emerging in the design stage of MotionMap, a smart transport initiative developed in the context of 'MK:*Smart*', a £16m smart city programme focused on Milton Keynes, UK (see http://www.mksmart.org/about/). Here, a city-wide sensing system integrated with other databases will provide real-time information about vehicular and pedestrian movement. However, such a sensing system raises issues about the balance between cost (in the form of intrusions on privacy) and benefits.

This paper seeks to contribute to the ongoing conversation about big data and smart cities. Big data is the broad label used to describe a new generation of technologies and architectures designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery and/or analysis (Gantz and Reinsel, 2011). There is no agreed academic or industry definition of big data, but a survey of the emerging literature denotes a number of key features. Velocity, volume and variety are generally agreed to be the defining technical characteristics of big data approaches. To this needs to be added the value that big data solutions create through large amounts of complex data being created in or near real time. Projects described as big data are often exhaustive in scope, striving to capture entire populations or systems and fine-grained in resolution, aiming to be as detailed as possible (Batty, 2013; Kaisler *et al*., 2013; Kitchin, 2014).

There is a coincidence between what are now being called 'smart cities' and big data, with smartness in cities pertaining primarily to the ways in which networks of sensors can generate new data streams in real time with precise geo-positioning, and how the databases that are subsequently generated can be integrated to provide value (Batty, 2013). As computers have become smaller, they have become spatially all pervasive, located anywhere and everywhere within the city and generating vast amounts of data on urban flows. This miniaturisation can be harnessed through several mechanisms, either as an enabler of automated surveillance, through the deployment of sensor networks, or through active participation of citizens contributing data through the sensing, computing and communications capabilities of social media and mobile devices. Each of the different approaches has its own balance of costs and benefits. Expected benefits generally include improved efficiency of city administration and increased economic competitiveness as data become input for digital and creative economies (Kitchin, 2014). However, those benefits are potentially overshadowed by risks like the corporatisation of city governance and the erosion of privacy through the panoptic city (ibid).

Literature on big data and sensing systems suggests that intrusions on privacy can be accepted by the public, but only if the benefits surpass the perceived loss of control over personal information (Chan *et al*., 2012; Cruickshanks and Waterson, 2012; Westin, 2003). The authors have participated in a series of smart transport workshops undertaken in Milton Keynes linked to the development of MotionMap. These workshops, part of the wider MK:*Smart* project, suggest that citizens feel that they bear the cost of smart cities through potentially intrusive surveillance producing sacrifices in convenience and privacy, while the gains are captured by industrial and governmental actors. As a result of this exploration, the smart transport system being developed in Milton Keynes will be redesigned to take into account citizens' concerns and the potential benefits that they consider compelling (and those they consider are not!).

The series of citizen workshops to develop MotionMap provided an opportunity to gain feedback on citizen's perspectives regarding different sensing approaches and on the potential value of the data created by this sensing system. Participant observation focused on citizens' concerns regarding monitoring of traffic and pedestrian flows and identifying opportunities to create value through the data made available by urban sensing systems. This balance has important practical implications for the smart mobility project in Milton Keynes and also for the understanding of public attitudes towards the smart city.

The overarching smart transport system being developed in Milton Keynes reflects a growing trend for urban development in which information and communication technologies (ICTs) play a central role. The trend is exemplified by projects around the world such as future city Glasgow, the Songdo International Business District and Masdar City, among many others (Shelton *et al*., 2015; Viitanen and Kingston, 2014). While the trend toward global urbanisation continues at pace, environmental constraints are likely to limit city growth and economic development (Banister, 2005; Kitchin, 2014). However, by augmenting city management and providing opportunities to technological innovation and entrepreneurship, ICTs are expected to help overcome some of these growth constraints (Kitchin, 2014; Morozov, 2013).

A growing criticism, however, is that because of the techno-utopian, corporatist nature of the smart city vision, the social dimension of the city is often neglected (Gibbs *et al*., 2013; Hollands, 2008; Kitchin, 2014). Actors responsible for implementing and managing smart city projects often come from technical, industrial and/ or city management backgrounds and thus tend to favour predominantly techno-utopian visions of the smart city. Such visions often assume that a passive and compliant citizenship will accept ubiquitous sensing and surveillance (Söderström *et al*., 2014), as smart city projects will be seen as evidently efficient, sustainable, competitive, productive, open and transparent (Hollands, 2008; Kitchin, 2014). The sensing and surveillance systems implied by this vision are not subject to a critical stance (Wolfram, 2012), but analysed through a perspective of 'instrumental rationalism' (Mattern, 2013) or 'solutionism' (Morozov, 2013) under the assumption that big data is objective and neutral, or even benign (Kitchin, 2014).

Critics argue that such projects risk failure because of lack of citizen engagement or outright backlash. The vehement opposition to the installation of smart metres in the USA is a case in point (Lineweber, 2011). Concerns about privacy associated with the sensing systems used to monitor urban flows (e.g. of energy, vehicles, and people) are viewed as a likely cause of citizen resistance (Fernback, 2013; Greenfield, 2013; Kitchin, 2014, Lyon, 2001; Martin *et al*., 2009; Westin, 2003; Zachary, 2011). While these concerns are usually raised within the context of smart cities, they are also very relevant to smart projects of a more restricted scope, like the MotionMap smart transport project discussed here. Management of transport activities through different layers of ICT systems is already widespread (Glancy, 2004), and movement almost never proceeds without traces being left on computers and cameras (Kitchin, 2014; Tiesdell and Oc, 1998). Indeed, the Orwellian Big Brother is frequently used as a metaphor for the surveillance and top-down control by government actors implied by the large-scale urban sensing systems required by smart transport (Cruickshanks and Waterson, 2012; Urry, 2007).

Empirical studies suggest that citizens seek a middle ground, balancing perceived costs in terms of lost privacy against the potential benefits of sensing systems (Cruickshanks and Waterson, 2012; Westin, 2003). This paper reports and discusses a series of MK:*Smart* citizen engagement workshops organised to seek insight into how to balance the costs and benefits of sensing systems in the context of the MotionMap smart transport system. Participant observation of a development process suggests that citizens of Milton Keynes, potential subjects, users or participants of such a smart system and MotionMap did not fully embrace the techno-utopian vision of smart city managers nor the critical stance of smart city detractors.

The 'three pillars of sustainability' are used in this paper as a heuristic for assessing costs and benefits of different smart city visions. The three pillars are a loosely defined set of dimensions of sustainability, often used heuristically for analysis and assessment of sustainability-related developments (Colantonio and Lane, 2007; Elkington, 1997, 1998; Hansmann *et al*., 2012). The three pillars are environment, economy and society. As a metaphor, the image of the three pillars suggests that if one pillar is weak, the whole structure becomes unstable and unsustainable in the long term. Rather than identify trade-offs, the three pillars can be used to search for synergies, framing sustainability projects such as smart cities not in terms of carefully engineered trade-offs between the pillars but as win-win combinations (Hansmann *et al*., 2012). However, there is general agreement that the pillars have not been equally prioritised by policymakers and the industrial actors who shape smart city narratives (Söderström *et al*., 2014).

The three pillars of sustainability provide a basis for analysis of the case study presented in Section 2. In Section 3, results, the observations from the workshops are summarised, exploring citizens perspectives the different forms of value created or destroyed by smart transport. Section 4 discusses the results and provides conclusions to this research.

2. Case study: MotionMap in Milton Keynes

2.1 Background

Located approximately 80 km north of London, Milton Keynes was initially developed under the UK's New Town legislation and now has a population of about 260 000. Milton Keynes has the UK's highest rate of job creation, with an 18·2% growth between 2004 and 2013 (Centre for Cities, 2015), and is expected to have a population of over 300 000 and a further 42 000 jobs by 2026. Consequently, traffic growth of some 60% is expected (MK Council, 2012). However, practical capacity expansion (e.g. enlarging road and junction capacity) can address only 25% of that predicted increase (Innovate UK, 2014).

A smart transport solution to better manage transport demand is sought as part of MK:*Smart*. MK:*Smart* is a collaborative smart city initiative supporting the design and development of smart solutions to address demand-related issues in Milton Keynes. MK:*Smart* comprised various work packages to address issues related to energy, water and transport. MotionMap, the main deliverable for the transport work package in MK:*Smart*, is an urban sensing and visualisation system designed to explore and develop the concept of cloud-enabled mobility. This concept seeks to connect users with information and other cloud-based services (e.g. booking and billing systems) in such a way as to support the development of more sustainable travel and to enable users to make informed, flexible and spontaneous travel choices. An important component of the cloud-enabled mobility concept is a live and interactive system for sensing and visualising real-time information about the movement of people and vehicles in the city, including routing, public transport timetables, delays and real-time indicators of pedestrian and vehicular density and activity. This information will allow the user to choose more efficient and convenient transport alternatives, avoiding congestion by choosing alternative modes of travel, times or routes.

The projects being developed under the MK:*Smart* programme, including MotionMap, are expected to support the development of a network of actors in industry, government and civil society that will find the data hub valuable and who will support it after the end of funding in 2016. This strategy aligns with future cities strategy in the UK, which seeks to 'move beyond where we are at the moment – which is a series of discrete pilot projects which are in effect proving the concept, often with their own bespoke funding arrangements – to a point where this is simply the way we do things' (Byles, 2015).

To achieve this outcome and build a critical mass of supporters, MK:*Smart* is structured so as to address specific local needs. Geoff Snelson, Director of Strategy at Milton Keynes Council, said of smart city projects, 'Many of these solutions are known, but they need to be bespoke to the particular environment or circumstances of the place and that requires a degree of interaction – people spending time together working through a solution collectively, rather than turning up with products expecting a city council, for example, to buy stuff' (Moore-Colyer, 2015).

2.2 Data collection

One of the principles guiding the design of MotionMap is that the smart city has potential to act as a living laboratory, a real-life setting where user-driven innovation can drive the co-creation process for new services, products and societal infrastructures (Bergvall-Kareborn and Stahlbrost, 2009; Jellinek, 2014). Community Action MK (CAMK), a local registered charity that specialises in community involvement, leads the Citizen Lab activities in MK:*Smart*, which involve a variety of sectors including city administration, industrial partners, citizens and civic organisations (CAMK, 2014). Collaboration with this organisation benefited from their experience in networking with the voluntary and community sector so that the workshops would reach participants representing a cross-section of Milton Keynes' citizens, securing a variety of perspectives. Collaborations with CAMK included workshops related to general themes (e.g. 'learning to live with big data') and also workshops centred on specific issues, like transport. Workshops were organised in collaboration with people from the relevant work packages. Two of the authors of this paper provided support for three workshops centred on transport issues and took the role of participant observers.

Workshop participants, recruited in collaboration with CAMK, were self-selected. Participants came from a variety of backgrounds, with the common denominator being an interest in (or dissatisfaction with) the state of transport in Milton Keynes (Figure 1). A pedestrian-oriented workshop centred on footpath sensing reached an older and less tech-savvy demographic and was also attended by members of a local cyclists touring club and visually impaired members of the MK Reader Service. A more general 'future of transport workshop' attracted a mix of participants including business actors with a higher level of technological literacy. Workshops were preceded by a description of the planned design for MotionMap and its benefits: In addition to the background information about MK:*Smart* and the concept of cloud enabled mobility, the various data sources feeding into the system were described including parking sensors, databases of transport providers and information provided by the council. Description of the system was followed by discussions in small groups with the researchers acting as moderators. Participants were prompted to voice their concerns and to discuss the applications they would like to see developed to make use of transport data. The three pillars of sustainability provided a useful framework for discussion of the expected benefits of smart applications, as it prompted an exploration that went beyond economic cost–benefit analysis and included environmental and social considerations. The workshops informing this paper took place ahead of the early design phase before the device was available in prototype form. This allowed the results of the workshops to be used to develop a specification, so new prototypes and new scenarios could be introduced for subsequent discussions, making the collaborative process iterative.

Figure 1. An MK:*Smart* transport workshop under way at the Transport Catapult in Milton Keynes (photo: author's own)

3. Observations

A series of increasingly refined mock-ups and non-functional prototypes of the MotionMap application, illustrating a developing vision for sensing and visualisation of urban flows, were used to initiate dialogue in the citizen engagement workshops (Figure 2). The initial mock-ups depicted an application that would rely on anonymised data from mobile phone sniffers to track the movement of vehicles and pedestrians, making visualisations available in real time to enable spontaneous transport decisions by citizens. The application would also keep historical records for use by city managers and transport planners. The implied benefits of this approach included improved efficiency of existing transport infrastructure, improved efficiency of transport services, reduced carbon emissions, and a reduction of the time spent sitting in congested traffic. The central assumption underlying the initial design was that the availability of real-time transport information would provide opportunities for reducing peaks in transport demand. For example, employers would be able to use the MotionMap to schedule working time for employees so they can avoid congestion.

Workshop participants were predominantly sceptical about the benefits provided by the initial design of MotionMap as conveyed by the mock-up. As stated by one of the participants with a business background, 'Gridlock happens 2 hours out of 24 and everyone knows it but everyone has to travel during peak hours anyway. We have been having this conversation since 30 years ago.'

Figure 2. Mock-up visualisations of MotionMap

Another potential benefit of MotionMap discussed in the workshops was the provision of real-time, low-cost travel plans. Personalised travel plans developed by transport experts already deliver this sort of information (but not in real time). Traffic reductions of 11% can be achieved through the adoption of such plans (Cairns *et al*., 2008). However, the benefits of automating this approach through MotionMap were not compelling enough to attract the interest of workshop participants. The expected benefits in terms of saved time and fuel were expected to be negligible and few environmental benefits were anticipated.

Rejection of MotionMap as originally conceived as a navigational tool for transport users and a data-gathering tool for city managers was used to prompt the exploration of alternatives. Workshop participants were dissatisfied with the state of transport in the city and saw the potential for reframing MotionMap as a platform for making their concerns and points of dissatisfaction visible to transport planners and city managers, communicating their concerns with a higher chance of action to resolve these. Automated sensing of urban flows would be complemented through active reporting by citizens. This change of perspective revealed a potential to go beyond the original MotionMap design to a more participatory conceptualisation. In systems based on participatory sensing, individuals choose to participate, either altruistically or out of personal and/or financial interest. A participatory system design focuses on tools and mechanisms that assist people to share, publish, search, interpret and verify information collected through the sensing system (Lane *et al*., 2008, Lim *et al*., 2009).

Citizens' interest in a participatory approach to urban sensing became more concrete in sessions focused on specific transport practices, such as walking and cycling. Pedestrians and cyclists shared concerns and were interested in adding a mobile phone feedback system for reporting and addressing issues like glass on cycle routes, bad road surfaces, or insufficiently illuminated footpaths. Unlike motion information that would be captured by the system automatically, incident information would depend on active participation by the users, who would take photos in location to send in. Incidents would automatically be reported to the council or other relevant persons. Participants were aware of similar tools which are already available (e.g. Trolleywise, Fixmystreet), but were dissatisfied with the piecemeal approach fostered by the multiplicity of specialised tools. Integrating multiple streams of live incident data in the MotionMap was of interest to workshop participants because it would provide a single point of contact and because it would make all incidents immediately visible not only to authorities but also to other users, who could use this information to make informed choices when planning their route.

This active incident reporting by users was seen as a complement to the passive monitoring proposed in early MotionMap prototypes but not as a replacement for it. Automated monitoring of pedestrian and cyclist traffic would be beneficial when used in conjunction with incident reporting since it would allow the council to focus maintenance and prioritise upgrading, directing their limited resources towards the roads and footpaths with the highest utilisation.

Interestingly, this combination seemed to legitimise the passive, automated component of data collection, which had been largely viewed as disagreeable when deployed on its own. Workshop participants saw that an urban sensing system that could be used by city managers to visualise the flow of citizens (top-down) could also be used to make the actions of city managers more visible (bottom-up), increasing accountability. For instance, if citizens used MotionMap to provide real-time reports about bad road surfaces or broken lights, this would in effect produce visible and publicly available evidence regarding the quality of response of city managers.

The idea that the sensing and surveillance systems of smart cities could be used as a bottom-up approach to augment transport management was further developed in workshop activities centred on public transport. Public transport users were enthusiastic about using sensing systems to provide their own crowdsourced, real-time reports about the location of buses. This information would be of immediate use to other users, who could use the information to decide on the feasibility of catching a given bus or coordinating a multi-model journey, instead of waiting blindly for a bus and hoping for the best. Additionally, the accumulated records provided by this monitoring activity would make transport providers more accountable to citizens, as it would produce automated records of punctuality, occupation, and quality of service. This, in effect, would counteract the existing disempowering relationship between bus users and service providers. At the time of the workshops, transport providers were the sole gatekeepers of information needed by users and the information currently available online was perceived to be inaccurate and based on official schedules, even when stated as 'real time'. In this way, user-generated GPS information was seen as an opportunity to make better decisions (e.g. knowing the actual location of the bus before heading to the stop) and to hold companies accountable, for example, by creating an independent persistent and visible record of the punctuality of bus services, or lack thereof. Under those conditions, participants would agree to make their location data available because, when analysed over time and in conjunction with the aggregated data of their fellow bus users, it could be used to assess the performance of the bus company.

4. Discussion and future directions

MotionMap is an ongoing project and as such it is only just reaching the stage where deployment of a functional prototype is feasible. Understandings from the tensions discussed in this paper and the results obtained are being incorporated into the development of the final version of MotionMap. The conditions of funding by the Higher Education Funding Council for England (HEFCE) and the project metrics are centred on business impacts and a more efficient use of existing transport infrastructure. Reflecting this, most of the sensors and data feeds used as inputs for the current prototype are based on passive, efficiency-oriented sensing approaches (e.g. installing inexpensive cameras in key locations and performing on-site visual processing to automatically produce near-real-time anonymised traffic data). Results of the citizen engagement workshops discussed in this paper have made it possible to request funding to develop participatory features, for example, user annotations, photo-reporting and real-time tracking of public transport. System specifications have been amended to allow managers to monitor the use of the different features of MotionMap. The authors' expectation is that usage metrics, in conjunction with further workshops stimulated by increasingly refined versions of the prototype, will provide arguments for moving the design of MotionMap towards a more social and participatory approach as long as this can be proven to contribute to improved citizen engagement and to increased economic and environmental benefits.

Results from surveys by Cruickshanks and Waterson (2012) suggest that success of smart transport depends on whether, in the eyes of the public, the potential benefits of future smart transport systems can outweigh the loss of control over personal information. These tensions should not be conceptualised in terms of linear trade-offs, but are multidimensional. Because of this, engagement with the citizens and potential users of the smart city is crucial for ensuring that the benefits of urban big data are perceived to be compelling and fairly distributed. Technologists and managers of smart city projects assume that benefits related to the environmental and economic pillars will lead to benefits for society, but in the case of MotionMap, a compelling value proposition could not be created simply by framing the benefits of smart technologies in monetary, or even in environmental, terms. For users, the promised economic benefits from smart technologies such as the MotionMap, the increased efficiency and the expected carbon reductions were not significant and compelling. Rather, transport users valued their convenience and comfort, as experienced through a liveable city with improved reliable public transport and where they spend less time sitting in traffic. That was the original concept of the eco-city in the 1980s and 1990s, but now is sometimes lost in the logic of carbon and competitiveness (Joss *et al*., 2013). Interestingly, the benefits that appeared to be more compelling for participants were not economic or environmental but were related to the social dimension. There is potential for empowering citizens through smart technologies by reframing the participatory sensing systems so that visibility would flow both ways. This model also implies that users will take an active role in providing transport data to the system, as opposed to having it 'harvested' from them through passive or opportunistic mechanisms. Users of the system agree to make their movement visible so that everyone can make spontaneous transport choices, but the citizen is not the only subject of observation. The actions of city managers and transport service providers are made more visible and accountable, too. The design of the sensing approach in the smart transport component is evolving from a panoptic, passive, top-down solution towards both active and bottom-up design. While the development of MotionMap itself is in its early stages, citizen engagement activities suggest that citizens are willing to make themselves visible as long as they can make themselves heard, too. There is potential for having big data without a big brother approach. However, this perspective may be overlooked by city managers and technology developers concerned with increasing the efficiency of urban flows.

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