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Removing Barriers for Citizen Participation to Urban Innovation

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Abstract The potential of open data as a resource for driving citizen-led urban innovation relies not only on a suitable technical infrastructure but also on the skills and knowledge of the citizens themselves. In this chapter, we describe how a smart city project in Milton Keynes, UK, is supporting multiple stages of citizen innovation, from ideation to citizen-led smart city projects. The *Our MK* initiative provides support and funding to help citizens develop their ideas about making their communities more sustainable into reality. This approach encounters challenges when engaging with citizens in identifying and implementing data-driven solutions to urban problems. The majority of citizens have little practical experience with the types of data sets that might be available or possess the appropriate skills for their analysis and utilisation for addressing urban issues or finding novel ways to hack their city. We go on to describe the Urban Data School, which aims to offer a long-term solution to this problem by providing teaching resources around urban data sets aimed at raising the standard of data literacy amongst future generations. Lesson resources that form part of the Urban Data School have been piloted in one primary and three secondary schools in Milton Keynes. This work has demonstrated that with the appropriate support, even young children can begin to develop the skills necessary to work with

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large complex data sets. Through our two approaches, we illustrate some of the barriers to citizen participation in urban innovation and detail our solutions to overcoming those barriers.

Keywords Big data · Data literacy · Citizen participation · Citizen engagement Smart cities

1 Introduction

Citizen-led smart city innovation is increasingly considered to provide an important counterbalance to the more traditional official-led planning. This shift from 'citizens as users' to 'citizens as active participators' and finally to 'citizens as innovators' is partially driven by the increasing number of open data sets that can be used to drive urban innovation (Anderson and Rainie 2012; Janssen et al. 2012). The expectation that citizens are able to first identify and then carry forward solutions to local problems is based on the premise that citizens have sufficient understanding of big data, smart city technologies and how open data can be used to drive urban innovation. While the average citizen is relatively comfortable in the use of technologies and the Internet for daily activities, big data and smart cities are new phenomena and therefore less familiar. As a consequence, the ability for citizens to use the available data and resources may be limited to those in society who already have good technical skills upon which to draw, such as those who would typically sign up for the wave of city Hackathons and Appathons that have been seen in recent years, the target audience for which is unlikely to reflect a good cross section of society.

This chapter will describe how we are aiming to remove barriers for citizen participation to urban innovation within the MK:Smart project (http://www.mksmart.org). This project is developing smart technologies for the city of Milton Keynes (MK), UK, in three key areas of energy, water and transport. Central to MK:Smart is a data hub which is aggregating both specific project-related data sets and other open data sets. The data hub, in turn, is available for businesses to develop applications, for citizens to create citizen projects and as an educational resource to teach data skills in schools. This chapter focuses on the latter two uses, through three related initiatives within MK:Smart.

The first initiative is the Community Action Platform for Energy (CAPE) project which has a focus on enabling bottom-up community energy projects. The second initiative is an ideation and innovation platform called Our MK (www.ourmk.org). The platform allows the crowdsourcing of ideas from citizens to change the city, some of which are funded to turn their idea into a reality. The third initiative is the Urban Data School (UDS) which is a school engagement programme, teaching data skills in schools using some real Milton Keynes data sets in the domain of energy. This is given focused attention within this chapter as the work with the young citizens becomes important when considering how to address some of the barriers revealed through the first two initiatives in terms of engaging citizens with data.

Based on an analysis of these related projects within MK:Smart—CAPE, Our MK and Urban Data School—we highlight the role of professionals and intermediaries in the process of making a city hackable due to their ability to help the public engage and organise around issues and provide them with skills, in particular data literacy skills. In the remainder of this chapter, we will describe each of these projects in detail before identifying a number of barriers to creating hackable cities.

2 MK:Smart

Milton Keynes is one of the fastest growing cities in the UK. Its population is expected to grow from around 230,000 today to over 300,000 by 2026. Such growth creates unsustainable pressure on key local infrastructure, particularly transport, energy and water. Each of these resources is already operating close to full capacity. The MK:Smart project is developing technology solutions aimed at addressing these issues and making Milton Keynes more sustainable in future. To support the technological innovation, MK:Smart is putting in place a data hub[1] through which all of the project-related data sets are aggregated along with additional open-source data, such as from the Milton Keynes Observatory (http://www.mkiobservatory.org.uk/) that contains data specific to Milton Keynes, open government data (such as census data), weather data and crime data. MK:Smart has put community engagement activities at the heart of its strategy through instigating three separate initiatives. This choice was made as it was felt that the citizen-centric activities would provide an interesting and important counterbalance to the more traditional 'top-down' activities that were also happening within the project, such as devising apps and services for improved energy efficiency, water use and transport.

3 Citizens as Innovators

There are both philosophical and practical reasons for promoting citizen participation in smart city projects. From the philosophical perspective, the argument is clear; those people that live in a community should have a sense of control over how that community is run. From a practical perspective, there are benefits to both individuals and city at large. For those who engage with civic affairs, benefits include increases in self-esteem, acquiring new skills and making new friends (Clary and Snyder 2002). Additionally, it has been noted that areas with 'good citizenship' get a better quality of service from their local government than areas with poor citizenship (Pattie et al. 2004). From the city perspective, by improving engagement and interaction, local authorities will become more aware of citizen needs and can better serve the public (Torres et al. 2006).

[1] http://www.mksmart.org/data/.

Recognising these benefits, some of the MK:Smart project activities have focused on engaging with citizens. Participatory Design approaches highlight how innovation can be amplified and citizen involvement prioritised (Carroll and Rosson 2007) through bringing together a variety of stakeholders. While citizen engagement is key, intermediaries have a significant role to play in achieving this through providing expertise and scaffolding the hacking process.

3.1 Community Action Platform for Energy

The Community Action Platform for Energy (CAPE) project will develop a platform to enable bottom-up social action through fostering the development of community energy initiatives, which can make a better use of energy, reduce CO_2 emissions and moderate citizens' fuel bills. This platform will connect citizens with a number of energy-related data sets and will provide them with a range of analytic capabilities. Citizens will in turn provide their energy information, which will help to understand how energy is consumed in Milton Keynes, identify the factors influencing this consumption and highlight opportunities and potentials of future energy projects.

In addition to data provided by citizens, data sets provided by the platform will comprise a mix of open and licensed urban data, including, but not restricted to, satellite and aerial imagery-derived data sets (such as ground source heat pump potential), socio-economic data (such as selected census data) and energy data sets (such as domestic electricity consumption data). Analytics will comprise basic statistics values such as average, median and standard deviation to characterise features under inspection, and more advanced statistics and inference mechanisms such as cluster analysis to group together householders with similar characteristics. The platform will also support the representation and exploration of spatial data in the form of a queryable map, which will be useful to represent satellite and aerial-derived data.

Citizens will be able to use the platform in different ways. Individual householders can use the platform to explore their consumption patterns, their insulation levels and their potential to install solar panels, compare them with general trends in Milton Keynes and with other people and learn from the experiences of others. With this information at hand, they can decide if there is potential to improve the use they make of energy. The platform will connect householders to users with similar interests and to existing communities they could be interested to join. In case a user would like to lead a new project, the platform will provide them with information about how to start a community energy initiative, funding opportunities, existing technologies that could fit their initiative and advice and good practice examples from existing projects.

Existing communities will be able to share their projects and experience within the platform. This will allow them to gain visibility amongst potential new members and to foster the growth of the projects. Additionally, they will benefit from the data sets provided by the platform and the data provided by users about their consumption patterns, measures they have taken to lower their bills and energy infrastructure

they have in place, such as solar panels. Communities will also use the analytical capabilities provided by the platform, which could help them to make better informed decisions and find potential householders interested in their initiative. Therefore, this platform will support active collaboration amongst communities and individual users, facilitating the collective identification, analysis and interpretation of data sets, inspiring and guiding collective action that will empower communities to collectively decide how they want to consume energy. Communities will then play a key role to maintain energy security, tackle climate change, save money for citizens and help those in fuel poverty.

3.2 Our MK—Supporting Citizen Innovation

In addition to researcher-led innovations such as CAPE, in which researchers choose the domain and frame the space of possibilities for engagement within it, the MK:Smart project adopts a user-centred approach and has set aside resources to support the development of citizen projects that 'hack' Milton Keynes. These citizen projects are conceived, designed and implemented by citizens with support from the MK:Smart team. We have developed an online platform (www.ourmk.org) that facilitates this process, capturing the ideas of citizens, from which the project team select a number to be realised.

To support the citizen projects, an online platform has been developed (www.ourmk.org). The Our MK initiative captures citizen ideas for changing the city for the better. Citizens have been able to apply for funding and support from the MK:Smart project to turn their idea into a reality. There have been 13 successful projects realised this way. Our MK acts as a starting point for dialogue around which projects are of interest to the citizens, are feasible to create and are likely to make a difference to the city. Those projects that fulfil these criteria are being funded and supported, thereby helping citizens to hack their city. Key to the success of this platform is the involvement of Community Action MK (CAMK), an organisation who support communities within MK, in particular engaging with the more disadvantaged and lower socio-economic regions to speak with citizens and discover their concerns. CAMK provide valuable insight into how to engage the public with the ideas of MK:Smart and to further elicit project ideas. CAMK act as mediators, first learning themselves the key ideas and then working out strategies for community engagement and knowledge exchange.

To help bootstrap the platform and encourage citizens to post their ideas, CAMK have utilised their ten Community Mobilisers. Community Mobilisers are individuals whose role is to support people to have a voice in their community. The Community Mobiliser approach is based on the premise that residents are the experts about what they need and want and should be supported to play an active role in decision-making. Mobilisers visit areas within Milton Keynes that are identified by the council as being most in need of community support and engage with citizens through a range of one-to-one conversations, group discussions or hosting stands as part of community

events. Mobilisers have expertise in engaging citizens and eliciting their issues and concerns, which are recorded, actioned and followed up. As such, these individuals are key intermediaries in organising and mobilising citizens, helping to achieve cities that are hackable.

In addition to the work of the Community Mobilisers, we have also been engaging citizens through targeted workshops and roadshow events. Six workshops were conducted between April and September 2014, attended by a total of 104 Milton Keynes citizens (with 33 citizens attending multiple workshops). From these workshops, we collected 198 dialogues related to sustainability concerns in Milton Keynes. Subsequent dialogues have been collected as part of ongoing roadshows which started in October 2014 and have visited 22 locations so far, with many more planned in the coming months. This process has so far elicited 591 dialogues. These can be loosely categorised according to the main smart city topic they address: 43.7% of conversations related to transport issues, 34.2% to energy and 22.1% to water.

Ideas alone are interesting but where we deviate from previous crowdsourcing approaches (e.g. Schuurman et al. 2012) is that these ideas are then refined into viable projects that have both a strong plan of action and a team of volunteers to carry them out. Since the Our MK website went live at the beginning of July 2015, over 3,500 people have visited the site, viewing nearly 17,000 pages of the site. Fifty-one ideas have been posted to the site of which 14 are being considered for support. The ideas we have received are extremely diverse ranging from promoting low-cost solar installations to drilling water bore holes, from installing digital signage on cycle paths to developing a scheme to promote locally grown food. Details on the ideas we have received, and the projects we are supporting, can be found on the Our MK website (www.ourmk.org).

4 Challenges to Facilitating Citizens as Innovators

Through developing our approach to facilitating the ability of citizens to hack their city, we have identified a number of open questions. We have had to produce answers for some of these questions such that the MK:Smart project can progress; we note that these answers are not optimal and remain open to discussion.

The first important issue that needs addressing is that of governance and control—who has control over what projects are encouraged and realised? Within the programme, we have outlined the provision of funding and expertise is still governed by MK:Smart meaning that ultimately we as researchers have control over which citizen-led projects are realised. The majority of citizen hacks will require some form of resources—be that money, time, technical expertise or access to organisational policies—that are not always easily accessible to groups of citizens. An important issue then remains of determining who should control the hackability of cities? While city councils have democratic legitimacy, ‘hacking’ can be understood as attempts to circumvent official interventions or to demonstrate a need to democratic institutes. Should citizens be able to hack their cities without interventions

from research projects, councils or businesses? Where do the required resources come from and how do you form groups around particular issues without a single central authority? These are significant and complex questions which need to be considered if we want to open up innovation to ordinary citizens.

This is particularly complex when we consider how long-term strategic impact is engendered. Long-term success necessitates that projects have stable sources of money and a commitment from citizens to be involved in the project over a long period of time. The MK:Smart project plans on helping successful citizen-led projects become sustainable through using our contacts with the business community and CAMK's experience of creating charities, co-operatives and community enterprises to ensure that any project which has had a positive impact can continue to benefit the local community. While this approach is inherently unscalable, due to the resources committed by the research team, as far as the authors are aware no other project has attempted to create sustainable projects and developing a mechanism to facilitate such projects remains a challenge.

An additional issue we continue to grapple with is the dissemination of results to other smart city projects. Many of the findings or issues we have uncovered are of a practical rather than academic nature and are not necessarily suitable for discussion within academic publications. How then do we discuss, experiment and improve upon our methodologies for engaging and supporting citizens in developing innovations? Furthermore, it is not yet clear how transferrable results are from one city to the next. Each city has its own governance structure, sense of community and set of challenges. Sharing best practice is key to ensuring that cities become hackable without repeating the mistakes of others; how that is best achieved is not yet clear.

One approach to facilitating citizens' innovation is to simply release data sets to the public (Williams 2015). However, releasing this data and expecting city-level hacks to occur organically are relatively optimistic. The UK government has opened up its non-personal, non-sensitive data sets for other people to reuse through the data.gov.uk website. At the time of writing, there are 24,992 different data sets and only 372 apps. Generating 372 apps is a big achievement but is orders of magnitudes smaller than what could be achieved using these data sets.

The idea of 'hacking' a city or developing a city-centric app requires not only a host of technical skills but also an appreciation of data as a resource for change. This ties into the idea that citizens need to have a certain level of data literacy to be fully empowered. Big data and smart cities are new phenomena and therefore unfamiliar to many people. For example, the dialogues the MK:Smart project has gathered from citizens have been processed into 101 ideas around improving the local community which do not focus on the use or generation of data. These range from Segway hire schemes to heated bus shelters, from better lighting on the cycle network to community-funded water butts.

The idea of 'hacking' a city has got to account for the issue of the digital divide (Norris 2001). The digital divide is instantiated in three forms across smart city projects—who is producing the hacks, who is using the hacks that are produced and

also who is producing the data used for the hacks. In each case, at the moment the answer is technologically aware users—a small segment of the population as a whole and, arguably, the citizens who are least likely to need help in improving their local communities.

5 Addressing the Digital Divide Through Data Literacy

The digital divide essentially faces two challenges. First, in the short term, we need to develop approaches to open up the possibilities that data gives in terms of hacking cities. But while increasingly a large amount of data is accessible to a large segment of population, only a few people are at home with the interpretation and analysis of data. This disparity between data access and data literacy may add to digital inequality, thus hampering the empowerment of citizens and contradicting the purposes behind the openness of data (Anderson and Rainie 2012). Therefore, in the longer term we need to tackle the problem by raising the general level of data literacy amongst school leavers such that they can become more informed citizens.

Data literacy is typically defined as the ability to explore, interpret, analyse and contextualise data. It may include a wide and diverse range of skills such as 'the ability to: formulate and answer questions using data as part of evidence-based thinking; use appropriate data, tools and representations to support this thinking; interpret information from data; develop and evaluate data-based inferences and explanations; and use data to solve real problems and communicate their solutions' (Vahey et al. 2006). This implies that teaching and improving data literacy would require a cross-disciplinary approach.

There have been some previous projects that have focused on improving data literacy of school children. These tend to incorporate activities both inside and outside the classroom. Lee and Drake (2013) made use of students tracking and reflecting on their own physical activities to learn concepts such as the impact of outliers on means and medians. The City Digits project of Williams et al. (2014) aimed at teaching data literacy skills to school children by encouraging them to investigate social issues in local, urban context. While these projects no doubt present interesting approaches for teaching specific data skills with small, personally collected data sets, they do not address the particular challenges of data literacy related to asking questions, analysing and drawing conclusions from large externally sourced data. The Urban Data School project focused specifically on how to engage young learners with large data sets they had not collected themselves.

6 The Urban Data School

The Urban Data School (UDS) is an initiative designed to improve data literacy amongst 8–18-year-old school students. The UDS aims to create a next generation of

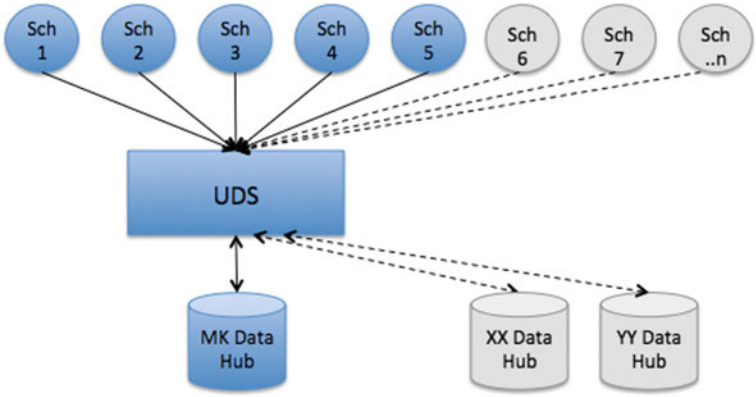

Fig. 1 Urban Data School—connecting schools to real urban data

school leavers who are comfortable in asking and answering questions from data, who can critique data, use it as evidence to tell stories and who can recognise opportunities for using data to their own benefit or the benefit of their community. The UDS will connect schools, teachers and students to real, urban data sets and provide support for students to get hands on with data and begin to ask and answer their own questions. The MK:Smart data, as provided through the data hub, provides a starting point for testing the approach, providing local schools with data sets related to their local area. The eventual aim is to integrate additional data to make the UDS a national, or possibly international, resource (Fig. 1).

6.1 Conducting Inquiries with Real Urban Data sets

An approach has been developed for teaching data literacy using real-life urban data sets based on the principles of data inquiry and using PPDAC (Wild and Pfannkuch 1999) as a starting point for structuring tasks from urban data sets. The approach is designed to prompt students to use their interpretation of a 'snapshot' of a larger data set as a starting point for understanding how to frame further questions around the same data set or to bring in new data to the inquiry. Thus, students improve their ability to formulate and answer questions from data. Students are supported in learning how to create answers to questions which use data as evidence and to present these as stories. Tasks use real data that has been used as part of smart city research. While on the one hand students replicate to some extent the existing research, there is the possibility that students can find novel questions from the data and potentially produce some really innovative outputs. There are no correct questions to ask of the data, but the aim is to ensure that students present an answer that is backed up by evidence.

6.2 Data

Several energy-related data sets have been identified for use in schools. One is smart meter data from a number of Milton Keynes homes that can be used to ask and answer questions related to home energy consumption across one or more houses, to investigate individual appliance use or to find how much energy is produced by solar panels at different times of the day or year. Another is aerial-obtained data relating to the potential for houses in Milton Keynes to have solar panels, which can be used to ask and answer questions related to whether or not all buildings are suitable for the placement of solar panels. Finally, a heat loss aerial survey can be used to ask and answer questions around thermal efficiency of different houses, or types of building, across different estates in Milton Keynes.

6.3 School Trials

Lesson plans based on these data sets have been trialled in four schools—one primary school (year 5–9/10 years) and three secondary schools (2 with year 9–13/14 years, 1 with year 7–11/12 years)—in Milton Keynes. What follows is a high-level analysis of some of the results. Feedback from these trials indicates that schools have a clear interest in using real data sets, especially those related to the local context. Teachers report good engagement in sessions using these activities. Observations of students in both age groups reveal good competence in interpreting graphs of energy consumption (Fig. 2) and generation (from solar PV) and a good ability to interpret map-based visualisations and cross reference to other sources of data in a table. Both students and teachers have—on some occasions—been seen to ask novel and valid scientific questions (questions that were testable through the data) that was not part of the original teaching or student materials. This indicates that the materials can support this type of reasoning. Secondary school students further demonstrated that they were able to construct and execute their own queries and visualisations of data to begin answering some of their questions.

In addition to lesson plans based on existing data, students in two schools have been asked to design their own mobile phone app for smart city innovation. The app design sessions were run competitively. Student worked in groups and presented their ideas to everyone at the end.

The goal was to gain a better understanding of the conceptual difficulties students might face when thinking how to design solutions for their homes and communities. One group were given an open-ended task in which they could identify themselves a potential source of data to drive the mobile phone application to address some local issue. The other group were asked to assess their own home energy consumption by effectively being a ‘smart meter’ and recording usage of individual appliances. This group then was asked to find a novel way to visualise energy use in a home and to use this visualisation somehow within a mobile phone app for monitoring home energy

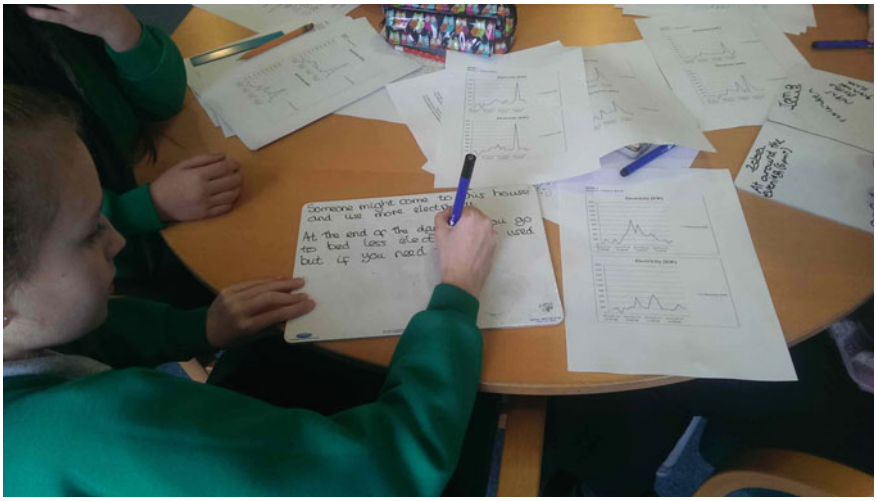

Fig. 2 Primary school children interpreting energy consumption graphs

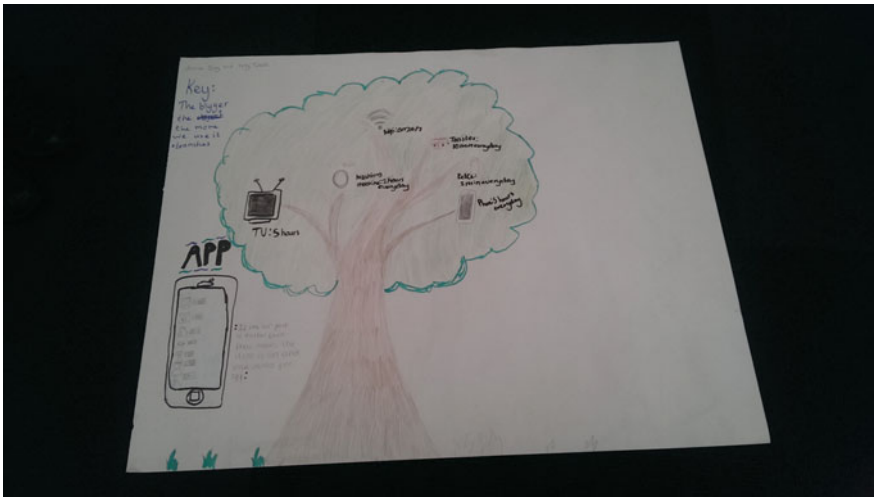

Fig. 3 Visualising energy as a tree

use. Students worked in groups and were tasked with thinking how a collective data set across a number of homes could be used as part of the app design.

These design sessions reveal that, without prompting any ideas, students find difficulties in creating novel data visualisations that are beyond their normal experience with graphs and charts. However, with support students can begin to imagine new ways to create visualisations. One example of energy visualisation is shown in Fig. 3.

Fig. 4 Judging the Walking Wardrobe app

Students also seem to have difficulty in comprehending how data that is collected from across a geographical area—e.g. from people or sensors—might be reasoned across to find knowledge to drive a smart city application. Students tend instead to think of collected data as a very localised resource that can be used as a 'lookup' to address an individual's need. As an example, students might propose to collect data from people about their clothing size and shopping habits. This was the idea behind the 'Walking Wardrobe' app shown being judged in Fig. 4. Instead of thinking how this collective data source could be used to identify clothing trends in Milton Keynes or inform shops about sizing of the population to better stock appropriate quantities of stock in the right size and style, students want to use this data to match individuals clothing requirements against the database of clothing shops in the Milton Keynes area so they can find where to go and shop for clothes.

Through working with teachers to prepare lesson materials and observing their use in the classroom, it is clear that teachers themselves can have some problems with working with these types of data sets. This can cause teachers to be reluctant to bring the materials into the classroom and teach something that they themselves are not familiar with. It is possible to overcome this barrier with a small group of teachers through individual discussions around the teaching materials and lessons. The goal of the UDS is just not to educate students but to engage the teachers themselves in learning more about working with and from these types of data sets.

7 Discussion and Conclusion

In this paper, we have described three distinct projects, linked through a common theme of urban innovation from city data. They each reveal some of the difficulties that citizens, who are not expert in smart cities and data analysis, face when engaging with complex urban data and in framing solutions to problems around it.

The CAPE project presents a researcher-led approach to innovation, in which the problem space is mapped out by researchers and an infrastructure built within which citizens can then identify common areas to start discussing community energy initiatives. This mitigates against many of the problems that citizens face in engaging with data by doing a lot of work 'upfront' to constrain the possibilities and support much of the interaction with data through easy to access visualisations. However, this facilitated approach, while it has obvious benefits, has the effect of reducing the space for creative innovation from the citizens themselves. The Our MK approach, on the other hand, is completely unrestrained, at least initially. Citizens are free to frame problems and solutions in any way they choose. However, this freedom is currently short-lived as only a few selected projects are taken further, and these are selected by the project team. Similar to CAPE, the realisation of the ideas is facilitated by researchers. The main difference is that in CAPE, the researchers choose the domain and in Our MK this is sourced from citizens. In both cases, the citizens themselves are part of implementing the solution. Our MK has also revealed that citizens find it difficult to frame problems around complex data and may miss some of the benefits that this data, as a resource for civic hacking, can bring.

Thus, through our work on the MK:Smart project, we have identified a number of substantial barriers as to how to encourage citizens to first identify the types of problems that can be addressed through data and then how to organise citizen projects to implement sustainable solutions. Specifically, we have identified that:

1. The majority of citizens are not data literate. We have proposed the Urban Data School as a solution for ensuring that the next generation are more data literate. However, it will be many years before they form the bedrock of a city's citizens and we must continue to explore mechanisms to educate older generations about how to use data effectively.
2. There remain open questions with respect to governance and control regarding citizen-led projects. Currently, all of the MK:Smart citizen initiatives remain under the control of the project. For us to enjoy truly hackable cities, we have to construct policies and governance models which allow citizens a greater degree of freedom in their hacking activities.
3. Financing and resourcing hacking projects remain a challenge. While a variety of options are available (crowd-funding, philanthropy, corporate sponsorship to name a few) until hackable city initiatives can highlight that they have led to meaningful change within the city, accessing these sources of funding remains a challenge.

4. Sustaining and scaling citizen initiatives are essential if hackable cities are to become effective at generating real change. However, identifying the mechanisms to do this is not easy and is not the typical focus of most research-led projects.
5. Sharing best practice is essential to the success of making cities hackable. However, the practical nature of much of this practice, and the unique challenges each city faces, means that how to effectively share these practices remains an open challenge.

These barriers are huge challenges to citizen innovation. We have overcome some of these barriers within the MK:Smart project, utilising community engagement techniques and long-term planning to develop solutions to unlock the potential of the citizens of Milton Keynes.

We do not want to conclude with a statement of doom and gloom. Early classroom trials have demonstrated the effectiveness of the UDS approach in eliciting novel questions and developing data literate students. Similarly, the Our MK initiative has highlighted the innovativeness and creativity of the citizens of Milton Keynes in developing ideas to address the sustainability challenges the city faces. This chapter and the work reported highlight the importance of researching how to overcome barriers to citizen innovation to ensure that citizens are fully aware of their environment and the possibilities they have to shape the cities they live in.

References

Anderson, Janna Quitney, and Lee Rainie. 2012. Big Data: Experts say new forms of information analysis will help people be more nimble and adaptive, but worry over humans' capacity to understand and use these new tools well. *The future of the internet*. Pew Research Center. http://www.pewinternet.org/files/old-media/Files/Reports/2012/PIP_Future_of_Internet_2012_Big_Data.pdf. Accessed 25 July 2018.

Carroll, John M., and Marry B. Rosson. 2007. Participatory design in community informatics. *Design Studies* 28 (3): 243–261.

Clary, E.Gill, and Mark Snyder. 2002. Community involvement: Opportunities and challenges in socializing adults to participate in society. *Journal of Social Issues* 58 (3): 581–591.

Janssen, Marijn, Yannis Charalabidis, and Anneke Zuiderwijk. 2012. Benefits, adoption barriers and myths of open data and open government. *Information systems management* 29 (4): 258–268.

Lee, Victor R., and Joel Drake. 2013. Quantified recess: Design of an activity for elementary students involving analyses of their own movement data. In *IDC'13 proceedings of the 12th international conference on interaction design and children*, eds. J. P. Hourcade, E. A. Miller, and A. Egeland, 273–276. New York: ACM.

Norris, Pippa. 2001. *Digital divide: Civic engagement, information poverty and the Internet worldwide*. Cambridge: Cambridge University Press.

Pattie, Charles, Patrick Seyd, and Paul Whiteley. 2004. *Citizenship in Britain: Values, participation and democracy*. Cambridge: Cambridge University Press.

Schuurman, Dimitri, Bastiaan Baccarne, Lieven De Marez, and Peter Mechant. 2012. Smart ideas for smart cities: Investigating crowdsourcing for generating and selecting ideas for ICT innovation in a city context. *Journal of Theoretical and applied electronic commerce research* 7 (3): 49–62.

Torres, Lourdes, Vincente Pina, and Basilio Acerete. 2006. E-Governance developments in European Union cities: Reshaping government's relationship with citizens. *Governance* 19 (2): 277–302.

Vahey, Phil, Louise Yarnall, Charles Patton, Daniel Zalles, and Karen Swan. 2006. Mathematizing middle school: Results from a cross-disciplinary study of data literacy. In *Annual meeting of the american educational research association*. SRI International. https://www.sri.com/work/publications/mathematizing-middle-school-results-cross-disciplinary-study-data-literacy. Accessed 25 July 2018.

Wild, C.J., and M. Pfannkuch. 1999. Statistical thinking in empirical enquiry. *International Statistical Review* 67 (3): 223–248.

Williams, Marie. 2015. Open data or closed doors? Centerforcities. http://www.centreforcities.org/wp-content/uploads/2014/08/13–12-10-Open-data-or-closed-doors1.pdf. Accessed 12 June 2015.

Williams, Sarah, Erica Deahl, Laurie Rubel, and Vivian Lim. 2014. City digits: Developing socially-grounded data literacy using digital tools. *Journal of Digital Media Literacy* 2(2).

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