Amplifying Quiet voices

Challenges and opportunities for participatory design at an urban scale

Gooch, Daniel; Barker, Matthew; Hudson , Lorraine; Kelly, Ryan; Kortuem, Gerd; Van Der Linden, Janet; Petre, Marian; Brown, Rebecca; Klis-Davies, Anna; More Authors

DOI
10.1145/3139398

Publication date
2018

Document Version
Accepted author manuscript

Published in
ACM Transactions on Computer - Human Interaction

Amplifying Quiet Voices: Challenges and Opportunities for Participatory Design at an Urban Scale

DANIEL GOOCH, The Open University
MATTHEW BARKER, The Open University
LORRAINE HUDSON, The Open University
RYAN KELLY, The Open University
GERD KORTUEM, The Open University and Delft University of Technology
JANET VAN DER LINDEN, The Open University
MARIAN PETRE, The Open University
REBECCA BROWN, Community Action: MK
ANNA KLIS-DAVIES, Community Action: MK
HANNAH FORBES, Community Action: MK
JESSICA MACKINNON, Community Action: MK
ROBBIE MACPHERSON, Community Action: MK
CLARE WALTON, Community Action: MK

Many Smart City projects are beginning to consider the role of citizens. However, current methods for engaging urban populations in participatory design activities are somewhat limited. In this paper, we describe an approach taken to empower socially disadvantaged citizens, using a variety of both social and technological tools, in a smart city project. Through analysing the nature of citizens' concerns and proposed solutions, we explore the benefits of our approach, arguing that engaging citizens can uncover hyper-local concerns that provide a foundation for finding solutions to address citizen concerns. By reflecting on our approach, we identify four key challenges to utilising participatory design at an urban scale; balancing scale with the personal, who has control of the process, who is participating and integrating citizen-led work with local authorities. By addressing these challenges, we will be able to truly engage citizens as collaborators in co-designing their city.

• Human-centered computing → Interaction design → Interaction design process and methods

Additional Key Words and Phrases: Participatory Design, Smart Cities; Citizen Innovation; Digital Civics

1. INTRODUCTION

In recent years HCI research has shown an increasing interest in the urban space. As 66% of the world's population is projected to be living in urban areas by 2050 [United Nations, 2014], it has become increasingly important to consider how urban areas need to be managed over the long term as resources become ever more scarce. This interest in the urban space coincides with a recent surge in Smart Cities, which use technology to enhance the quality, performance and interactivity of urban services, reduce costs and resource consumption, and improve collaboration between citizens and government [Chourabi et al., 2012].

Smart Cities introduce new challenges for participatory research and design. Cities are complex socio-technical assemblages of social groupings, spatial structures, physical infrastructure and human practices that are constantly working in a dynamic flux to reshape the urban experience [Kitchin, 2011]. As such, many Smart City projects profess a desire to involve citizens in their programmes of work as key actors in the city assemblage, recognising that technology alone is not sufficient to solve city-level problems [de Oliveira, 2016]. Morally, we can argue that citizens have a right to be involved in the design of systems that will affect their daily lives. Pragmatically, we recognise that users' input may increase the likely success of designed artefacts and services in terms of meeting the users' needs and encouraging user acceptance and use [Carroll and Rosson, 2007].

However, the traditional focus of the research community has been on the technological aspects of Smart Cities [Chourabi et al., 2012]. This means that our

understanding of how to construct meaningful procedures to include citizens in urban-scale design for informing Smart City programs is relatively limited. While Smart City projects have variously used citizens as data sensors (e.g. [Le Dantec et al., 2015]), actors to report on specific problems (e.g. [Benouaret et al., 2013]), sources of finance through civic crowdfunding (e.g. [Stiver et al., 2015]) or users of Open Data (e.g. [Janssen et al., 2012]), few empirical studies exist into the process of involving citizens at scale in Smart City projects where citizens are seen as collaborators rather than users, and as innovators rather than consumers [Schuurman et al., 2012]. Foth et al. argue that as HCI researchers we have a key role to play in this field, utilising our experience of designing with and for citizens [Foth et al., 2015].

The demographics of civic participation are known to be skewed; as Kavanaugh et al. observe, "education, income, and… socioeconomic status are generally accepted as strong, positive predictors of civic engagement" [Kavanaugh et al., 2005, p. 11]. Such inequality has been noted in Smart City engagement activities. In hackathons, for example, it can be challenging to include participants other than technically skilled young men [Decker et al., 2015; Richard et al., 2015]. This raises the question of whether Smart City citizen engagement initiatives can amplify voices not normally heard and support people who are not typically involved in traditional forms of civic action.

In this paper, we outline the citizen innovation approach we have developed alongside Community Action: MK, a charity whose purpose is to foster the voluntary and community sector in Milton Keynes, a city in the United Kingdom. We have been working together as part of the MK:Smart project, a publicly funded research project exploring how to develop Milton Keynes into a Smart City. Our focus has been to engage socially disadvantaged citizens in creating Smart City solutions that address community concerns. Our approach deliberately moves away from citizens having a peripheral passive role into one where they have the ability to actively change their local community. Our approach uses a variety of social and technological tools, taking place over a two-year period. Through analysing three sources of data collected from our approach, and by reflecting on our involvement in the process, we contribute an exploration of some of the challenges we have experienced in attempting to operate a participatory design process at an urban scale. These challenges will be important for others to consider when implementing citizen-driven urban projects in the future.

2. BACKGROUND AND RELATED WORK

While every city has certain unique issues, many of them face the same broad challenges such as rapid urbanisation, climate change and increasing pressure on city services such as transport and healthcare [Braun et al., 2012]. Smart Cities are one approach to addressing these issues. While there is no shared agreement of what constitutes a "Smart City" [Nam and Pardo, 2011], one of the broadest definitions is provided by Caragliu et al., 2011 who argue that a city is "Smart" when "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" [Caragliu et al., 2011, p. 50]. They go on to argue that a city is smart if the "community has learned to learn, adapt and innovate". Such a definition highlights the importance of a Smart City having suitable institutional policies in place to involve citizens in governance and to utilise their creativity and innovation in shaping their communities [Nam and Pardo, 2011]. This necessitates building on

research on citizen empowerment (e.g. [Fung, 2009]) while retaining a focus on the technological aspects of the Smart City agenda.

Some have critiqued Smart City rhetoric as being about corporations locking cities into particular technological platforms [Kitchin, 2014; Townsend, 2013]. Datta, for example, has argued that in India, "Dholera's fault lines are built into its utopian imaginings, which prioritises urbanization as a business model rather than a model of social justice" [Datta, 2015, p. 3]. While many of these business-led projects discuss the role of citizens, some have argued that the rhetoric around citizen engagement is not matched by action, with such projects asserting a view of citizens as consumers or customers [Schuler, 2016; Vanolo, 2016]. While this might be the approach taken by some Smart City projects, we reject the criticism that all Smart City projects operate in this manner. In the Smart City project we work within, and many others we have had contact with, citizen empowerment is conceived of as an important facet of the Smart City agenda.

In the following sections we first explore the theoretical underpinnings of large-scale participatory design. We then examine how these theories have been enacted in practice through the main approaches that have been taken to involve citizens in Smart City research, concluding that there is a need for a methodology for empowering socially disadvantaged citizens as active participants and innovators.

2.1 Participatory Design

Historically, participatory design (PD) has focussed on working with a small number of participants in a stand-alone application of some form of IT system [Clement and Van den Besselaar, 1993; Schuler and Namioka, 1993]. "Much has changed within PD since then, but the projects are still predominantly small scale, stand alone, and researcher led" [Oostveen and Van den Besselaar, 2004, p. 174]. There are some indications that while participatory design is successful in small-scale technical development projects, it may be less successful at company or sectoral level [Van den Besselaar, 1998].

In more recent years some researchers have proposed a shift in the conceptualisation of participatory design such that, rather than focussing on a well-defined product to be designed, participation is seen as being key to creating a long-term partnership for creating sustainable collaborative services [Ehn, 2008; Bjorgvinsson et al., 2010; Deserti, 2016]. "This is a shift that is characterized by a movement towards participatory design in open public spaces rather than within an organization" [Bjorgvinsson et al., 2010, p. 41]. Such a shift aligns with the Smart City agenda where participation is not only about designing a fixed product but also about involving citizens in the processes of the city. However, this realignment of the object of design does not address the concern of how to involve a city-scale population in a participatory design project.

The nature of who participates in the design process can take many forms. In small-scale projects, all the users of a product can be engaged in directly shaping the object of design. If the object of design is going to be used by a well-defined population with common characteristics, representatives from the population can be used as the design participants [Bergvall-Kåreborn and Ståhlbrost, 2008]. When working with a diverse urban population, neither of these options is ideal. Using direct participation would involve too many people to be manageable. The question then is how to recruit a meaningful set of representatives. Gidlund explains that to use "a useful number of representative users, we will have to extract a very large number of heterogeneous characteristics from a very small number of generalized

characteristics. Such an extraction, resting on what is considered as important characteristics in the specific situation, might run the risk of losing what really matters during the process because the information is mistakenly perceived as beyond the scope" [Gidlund, 2012, p. 14]. Furthermore, there are challenges with regards to the motivation to participate, with the design-process taking too long for immediate effects to be beneficial [Oostveen and Van den Besselaar, 2004]. Cities involve a hugely complex set of stakeholders including a range of citizens and community groups, businesses, local administrations, other public sector organizations, a variety of NGOs and 3rd sector organizations, making the negotiation process more challenging [Simonsen and Hertzum, 2008].

Given the challenges involved in using participatory design methods in large-scale urban projects, we now explore the main approaches that have been taken to involve citizens in Smart City research.

2.2 Citizens and Open Data

One of the most popular mechanisms in Smart City projects for engaging citizens is through *open data*, ensuring that as much city data as feasibly possible is accessible by citizens. One impetus behind the idea is that by releasing this data, citizens can utilise it and help produce services of social or commercial value [Bakıcı et al., 2013]. By increasing the amount of data accessible to citizens, a host of other benefits are thought to accrue; increased trust, greater transparency, and more informed decision-making are common examples [Janssen et al., 2012].

There remain a number of barriers to the success of open data as the mechanism for involving citizens in Smart City projects. McMillan et al. have outlined how city administration approaches to open data can "fail on the back of conflicts over control, finance, turf, or the complications of cities' procurement and regulatory responsibilities" [McMillan et al., 2016, p. 2934]. Similarly, Boehner and DiSalvo interviewed 13 people representing 10 organizations within Atlanta, exploring how civic leaders in a large US city approach the intersection of data, design and civics. They identified a number of issues regarding releasing data including "not having data because it isn't captured digitally, not having data because someone else controls it, having data but lacking tools or policy to coordinate access, and having data but not knowing what to do with it" [Boehner and DiSalvo. 2016, p. 2973].

Beyond the difficulties of releasing the data, open data on its own has little intrinsic value; value is only created by its use. Currently, open data systems are challenging to use – data sets are hard to analyse, and finding the required data is not straightforward [Janssen et al., 2012]. A typical example is Peterborough City Council's "Frozen Animals" dataset listed on data.gov, the UK government's data portal [Peterborough City Council, 2016]. The dataset consists of a table of animals (including cats, rodents and birds) and dates with each cell containing a number. There is no context around these figures and no explanation as to what they mean, rendering the data set essentially meaningless. The situation is no better for application developers, as Lee et. al demonstrate, providing an in-depth analysis of the challenges faced by developers in the creation of open-data civic apps [Lee et al., 2015].

The Royal Institution of Chartered Surveyors echoes many of these concerns in the context of the challenges of using data within Smart Cities [RICS, 2017]. Based on a series of interviews and survey responses, they note challenges including a lack of engagement by the built environment sector, issues around data confidentiality,

issues over the interoperability of data, and the top-down nature of much of the Smart City agenda.

To overcome some of these challenges, the city of Amsterdam[1] has instituted a weekly series of face-to-face workshops for civil servants and developers to demonstrate applications and data analyses to the public. It is unclear whether such workshops increase the use of Open Data or create beneficial outcomes.

Given these barriers, there is currently little evidence that the provision of open data results in citizens innovating and producing beneficial services. Until citizens can easily find and use data which is described meaningfully, it is impossible to determine whether the release of open data facilitates citizen involvement in Smart City projects.

2.3 Citizens as Data Collectors

Within the science community, the idea of "citizen scientists" has become popular, with members of the public becoming involved in scientific projects primarily by providing data [Wiggins and Crowston, 2011]. Models of the way in which citizens participate in these projects include contractual, contributory, collaborative, co-created and collegial projects, with an increasing involvement from citizens (see [Shirk et al., 2012] for details). Based on an analysis of 89 citizen science projects, Qaurooni et al. conclude that in 75% of projects citizens are mainly involved as contributory data collectors rather than being involved in more participatory roles [Qaurooni et al., 2016].

Within Smart City projects, this idea of citizens as data collectors encompasses everything from passive data collection, whereby citizens can install apps on their smartphones that then act as automated sensors (e.g. [Carrera et al., 2013; Le Dantec et al., 2015]), to participatory sensing projects in which citizens contribute to data collection in projects where the objectives have been set by the citizens themselves (e.g. [Balestrini et al., 2014]).

In such participatory sensing projects, some have argued that the rise of low-cost, citizen-accessible open hardware and software marks a shift in how citizens could interact with the city [Balestrini et al., 2014]. While there are some positive indicators that sharing environmental data can help achieve change, the current focus of such projects is on the development of sensors that share environmental data rather than on systems that allow citizens to directly change their communities using computing technologies [Diez and Posada, 2013].

Beyond these sensor-based schemes are initiatives in which citizens can contribute richer data. One of the most popular concepts is the development of platforms that allow citizens to report specific problems in their physical environment (e.g. graffiti) to their local government in order to have these fixed. Examples include Citizen Connect, Mark a Spot, FixMyStreet, SeeClickFix, and CrowdSC [Benouaret et al., 2013]. Additionally, a number of programs have been instituted to gather richer feedback on specific proposals (e.g. Commonplace, Stickyworld and Neighborland) or to assist with urban planning [Botero and Saad-Sulonen, 2010; Nuojua et al., 2010]. The HCI community has contributed to this discussion by considering how to redesign polling techniques including designing building-sized displays [Behrens et al., 2014], using custom-designed polling booths [Golsteijn et al., 2015; Taylor et al., 2012], public screens [Hosio et al., 2012; Schroeter, 2012; Valkanova et al., 2014] and building platforms for public

[1] https://www.amsterdam.nl/bestuur-organisatie/organisatie/overige/datalab-amsterdam/datalab-demo-3/

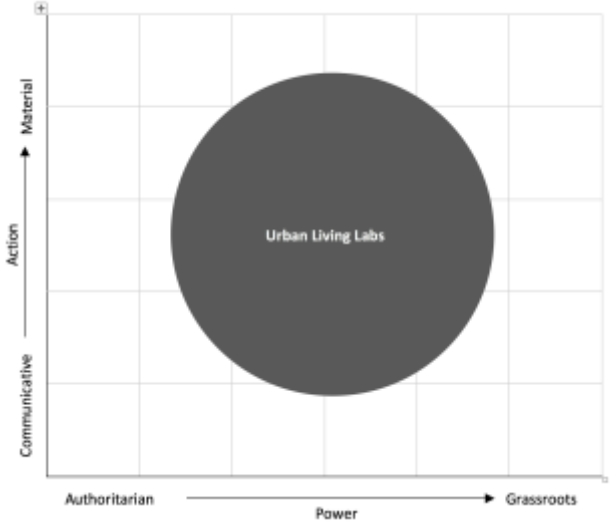
deliberation [Kriplean et al., 2012]. There are also some early indicators that gamifying the process of participation can help motivate participation without limiting engagement [Bianchini et al., 2016; Thiel, 2016] although it remains unclear whether this would work for all demographics.

While these initiatives for providing rich data go beyond traditional consultation models which limit citizens to being able to say "no" to a specific initiative [Botero and Saad-Sulonen, 2010], city officials and institutions currently lack the institutional policies and legal formulation to be open to this kind of citizen participation [Leighninger, 2011]. This is a major concern because the data provided by citizens is only useful if city officials respond effectively to the feedback. A common complaint in this area is that there is often a lack of communication as to how the citizenry's concerns are resolved in a responsive manner, leading to the disengagement of citizens from the civic arena [Botero and Saad-Sulonen, 2008; Hosio et al., 2012; Taylor et al., 2012]. The approach also remains essentially passive with citizens having little involvement in the process beyond contributing data.

2.4 Citizens as Collaborators

One proposed mechanism for involving citizens as collaborators in Smart City projects is the Living Labs approach which takes the form of a public–private–people partnership, involving users at all stages of the innovation process in order to co-create city services [Eskelinen et al., 2015]. The European Network of Living Labs defines Living Labs as "real-life test and experimentation environments where users and producers co-create innovations" [ENoLL, 2015]. However, this definition is broad enough to encompass a number of different understandings and methods of involving citizens, from user-centred to user-driven design [Almirall et al., 2012; Dutilleul et al., 2010; Vanmeerbeek et al., 2015]. Figure 1 demonstrates the range of activities covered by urban Living Labs. This lack of clarity regarding what a Living Lab actually is [Coenen et al., 2014] makes it difficult to assess whether Living Labs are a successful mechanism for involving citizens in participatory design processes within Smart City projects.

Figure 1. The range of activities associated with Urban Living Labs. From [Concilio, 2016]



The other main method of involving citizens as active collaborators in Smart City projects has been through short-term programs of development. One of the most common forms this takes is hackathons. For example, Helsinki organises an annual competition, using open data to stimulate the development of Smart City applications by local developers [Hielkema and Hongisto, 2013]. Similarly, the Catalyst project at Lancaster University instituted a series of co-production exercises whereby academics and community groups came together to develop solutions to social issues [Whittle, 2014].

An alternative approach focusses on the potential for using games as a mechanism for co-creating public services. Kauppinen et al argue that using games with small groups were an excellent mechanism for introducing non-experts to the complexity of decision making in public services and developing new skills [Kauppinen et al., 2016]. While a useful first step, the game does not involve progressing from the game to action.

Similarly, Bianchini et al. argue that gamifying the process of constructing informed proposals for change leads to stronger proposals alongside increased participation and engagement [Bianchini et al., 2016]. However, their trials are relatively short-scale (around 15 days) and it is questionable as to whether developing strong proposals is really empowerment or just a stronger, more educated form of information exchange.

While these short-term schemes can result in creating real-world change, they are limited by the quantity and the demographics of citizens they reach. A different approach was explored by Schuurman et al., who focussed on engaging with large numbers of citizens online [Schuurman et al., 2012]. Their project focussed on the city of Ghent where citizens could submit and evaluate ideas for Smart City innovations. Around 5,500 people visited the website contributing 128 ideas. The authors assessed the approach by comparing the citizen-generated ideas to ideas generated by city experts, concluding that user-generated ideas are less innovative but offer significantly more user benefit. This indicates that while ideation through crowdsourcing may not yield radical, breakthrough ideas, citizens seem better able to create ideas that provide solutions to their immediate problems. However, while successful at engaging large numbers of people, the approach was limited in that once the ideas were collected, no further action was taken.

2.5 Empowering Citizens as Designers

Our analysis of current methods of involving citizens in Smart City projects highlights the wide variety of approaches to working with citizens in Smart City projects. It also indicates that current approaches tend to be either small-scale or involve citizens in a relatively passive role.

This paper aims to address these issues and explore whether it is possible to design an approach to engaging large numbers of socially disadvantaged citizens as participatory designers in the context of a Smart City. We conclude that while our approach did provide an opportunity for individuals and communities to create change, our experiences highlight a number of barriers to urban-scale PD which need further research to better understand how to use PD methods at an urban scale.

In the next section we outline the citizen innovation approach we have taken which focusses on helping members of the public generate novel ideas and assisting those citizens in turning their ideas into action. We present three categories of data we have collected from our approach, and our analysis of this data allows us to

explore the challenges of empowering citizens from lower socio-economic communities in Smart City projects.

3. SCAFFOLDING CITIZEN INNOVATION IN SMART CITIES

Our work is situated within MK:Smart[2], a Smart City project based in Milton Keynes, one of the fastest growing cities in the UK. With the city's population expected to grow from around 230,000 today to over 300,000 within the next 10 years, Milton Keynes faces unsustainable pressure on key local infrastructure, particularly transport, energy and water. The project involves a consortium of Universities, technology companies, third sector organisations and Milton Keynes city council. The objective of the MK:Smart project as a whole is to develop novel approaches to manage future growth and to make the city more sustainable. The project is part funded by the Higher Education Funding Council for England (HEFCE), and part funded by the MK:Smart consortium partners. The project is led by the Open University.

One of the main streams of work within the project is devoted to facilitating community engagement and innovation in the context of a "Smart City". Our initial aim was to find, fund and support 10 citizen-led projects, with the funding parties each recognising that a lack of public engagement is a major obstacle for the long-term sustainable success of smart city initiatives. The three partners in this activity were the Open University, whose interests lay in the research element of large-scale PD in the context of Smart Cities; Community Action: MK[3] (CAMK), a charity whose purpose is to foster and support the voluntary and community sector in the city and who were interested in the project's potential to create change within local communities; and Graymatter, a digital marketing agency, who were contracted to develop the online platform used within the citizen innovation work stream.

With a lack of clear processes for undertaking citizen-driven activities [Gidlund, 2012], we have drawn on the concepts of open innovation [Chesbrough, 2003] and crowdsourcing [Stiver et al., 2015] in designing our approach to focus on the urban environment [Björgvinsson et al., 2010]. Numerous models of city participation detail how cities can involve citizens in the running of their communities, predicting a similar trajectory from information provision to shared discussion before moving on to active engagement and participation [Kolsaker and Lee-Kelley, 2008].

Basing our approach on Participatory Design traditions [Botero and Saad-Sulonen, 2008], we have thus taken such a model of participation and developed it into a four-stage model for addressing community issues.

1. The first stage is to *identify the problems* facing a community. We argue that communities often experience issues and concerns that are known by citizens but are not known, or are perhaps not considered to be important, by city officials. This is particularly the case in socially disadvantaged communities with low levels of civic engagement [Kavanaugh et al., 2005].
2. The second stage encourages citizens to *generate ideas* to overcome the identified issues. While generating ideas is a positive first step, unless those ideas are developed into actions, nothing will change within local communities.

[2] http://www.mksmart.org/
[3] https://communityactionmk.org

3. The third stage is *developing projects*. These turn ideas into reality as citizens coordinate and action their solutions.
4. Finally, the fourth step is *sustaining success*. A project is successful if it brings social benefit consummate with the level of investment. If a project is successful, it may be beneficial to explore opportunities to continue the project in the long term or to replicate the project across other communities experiencing the same concerns.

Progression through each stage requires a greater level of commitment from citizens and more involvement from staff at the OU and CAMK. This assists our ability to scale participation, since much of the problem identification and idea solicitation is led by citizens, allowing us to focus our time on working with and supporting project leaders. While this means our approach can gather a large number of ideas for change, it does limit our involvement in the more open-ended exploratory stages of the process. We have developed two interrelated mechanisms to facilitate citizen innovation at each stage of the process.

3.1 Community Engagement App

The first stage of facilitating community engagement and innovation is *identifying problems*. Given that cities have pre-existing infrastructures within them, the MK:Smart project recognised that CAMK's pre-existing connection with local communities would be invaluable for providing an understanding of the *problems* facing specific communities.

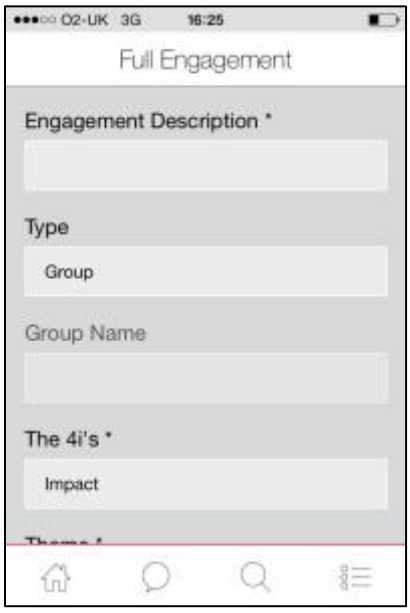
As part of their existing presence in the city, CAMK employed 10 Community Mobilisers (CM) who support local people to take action within their community. Each mobiliser works within a socially disadvantaged community. Within that community, the CMs provide information, help recruit volunteers and assist organisations with applications for funding. Fundamentally the role of a CM is about helping people help themselves, assisting them to develop the skills to undertake the actions needed to meet their needs. This can range from helping to organize and promote community events to helping individuals access vital services (such as legal aid). The CM program started in 2003, ensuring that each mobiliser has built up a large amount of visibility and trust within their community.

To understand their community, CMs spend a large proportion of their time discussing local issues and concerns with community leaders, helping people to start new community groups, and generally assisting anyone who lives in the community. This occurs at regular community activities (e.g. parent/toddler groups), community events (e.g. neighbourhood fairs) or at CM-instigated events such as specially organised workshops or by going door-to-door. Through these activities, mobilisers use their expertise in engaging citizens to better understand local issues and concerns at a community level.

These conversations provide an invaluable source of data about the *problems* facing communities in the city. While CMs had been taking notes on these conversations, they had no convenient mechanism to collate and compare these notes as a complete data set. The Community Engagement app was developed to support the collection of these dialogues (see Figure 2). The app allows CMs to record salient elements of their conversations in a lightweight manner. CMs now use the app to record notes that capture the essence of their conversations with members of public. These notes are called "dialogues". A single conversation may result in multiple

dialogues being created. The average dialogue is 40 words long, and can also include information regarding when, where and with whom the conversation took place.

Figure 2. An input screen for the Community Engagement App. The 4i's field refers to a classification CAMK use to sort dialogues as being related to Impact, Interest, Idea or Issue.



While it is unusual for this data to be shared beyond CAMK, we negotiated a data-sharing agreement giving us access to an anonymised version of the data set. We thus have 4,504 dialogues collected between January 2015 and March 2016, forming a data set that encapsulates the concerns of citizens and their thoughts and ideas about how to address those concerns. We are aware of no other Smart City project that has taken this face-to-face approach to understanding the city in which they operate. This forms the first of our three main data sets.

3.2 Ideation and Innovation Initiative

Moving beyond the identification of *problems*, we developed an initiative called Our MK[4] (see Figure 3) to facilitate the collection of citizens' *ideas* and, where appropriate, support these ideas into becoming *projects*. As noted at the outset of this section, the initiative involves three partners, each with expertise in technical systems (The Open University), community outreach (CAMK) or digital marketing (Graymatter). The presence of these partners meant that any of the collected *ideas* would benefit from differing kinds of expertise when assessing its potential to become a *project*.

[4] www.ourmk.org

Figure 3. The competition page of the Our MK website

The first stage of the initiative involved soliciting citizens' ideas for how to change their community. To help achieve this, we developed a web-based platform to crowdsource citizens' ideas about sustainability issues in their community. For some people this is where their involvement ended. For others, they decided to complete stage two of the initiative, which helped turn their *idea* into a *project*. This involved entering the funding competition, completing an application form outlining the project concept, a budget (up to £5,000) and any technical, commercial or community support needed to make their project a success.

The initiative was launched on the 22nd June 2015 and was widely advertised through emails to local organisations (e.g. youth groups, environmental groups, technology groups), newspaper advertisements, online adverts, social media, radio broadcasts and door-to-door leafleting in three neighbourhoods not served by Community Mobilisers. We also ran stalls at over 20 community events to promote the scheme. Furthermore, after the launch of the initiative, the Community Mobilisers promoted the initiative through their conversations in the community.

In addition to promoting the website, we ran a series of events to encourage face-to-face contact between citizens, ourselves and other city stakeholders. These events included individual meetings, networking events, drop-in workshops and seminars on specific topics (e.g. cycling). Since the launch of the ideation platform in June 2015, over 13,000 people have visited the site, and over 500 people have attended one of the associated face-to-face events.

As is typical of voluntary contribution websites, users exhibit varying degrees of engagement with the site [Hansen et al., 2014]. From June 22nd 2015 to January 2nd 2017 the website was visited 11,361 times by more than 8,141 unique visitors, viewing 34,840 pages during this time (as reported by Google Analytics). 3,177 of the visits (28%) were from visitors who had been to the site before. 319 people had become registered members.

Over that time period, 86 ideas were posted to the website by 73 individuals. Each idea describes a solution to a problem identified by the author. The average length of an idea posted to the website is 250 words. These ideas form our second main data set.

In addition to these ideas, 28 project applications for funding were submitted during this time period, of which 13 have been funded. The average length of an application was 3,477 words.

The decision of which projects to fund was made collectively by a small team of representatives from each of the three partners involved in Our MK. All members of staff working on MK:Smart made a recommendation, with the final decision being made by a committee of a single representative from each partner organisation. Decisions were made based on cost/benefit, community need, technical innovation and relevance to the concept of being a Smart City. At this stage of the analysis, we are using the projects to help illustrate the progression from problems through ideas to projects and to demonstrate the success of our outlined process. We examine the projects in more depth in Section 6. The 13 projects are:

1. Creating a treasure hunt app on the cycle path network
2. Developing an app to collect problems on the cycle path network
3. Recording videos of key cycle path routes
4. A pop-up shop for recycled furniture
5. An advertising scheme for low cost solar installations
6. Drilling a borehole at an allotment site
7. A food passport scheme to promote independent food
8. An app to promote breastfeeding-friendly locations
9. Developing an app for visually-impaired navigation
10. A series of community workshops on the Raspberry Pi computer
11. Developing an age-friendly map of Milton Keynes
12. Exploring ways of reducing food packaging waste
13. Detailed data collection regarding Fuel Poverty

While our direct involvement in these projects has finished, only two of the projects have ended completely (6, 7). The remaining projects were either pilots of schemes that the project leaders continue to work on (1, 5, 10, 11), projects that are exploring how they will continue to operate (2, 3, 8, 9, 13) or projects that form part of a commercial operation (4, 12).

We thus have three datasets available for analysis. First, we have the dialogues collected by the Community Mobilisers. Second, we have the ideas posted online by citizens. Third, we have the results of the funded projects, interview transcripts with the project leaders, and final reports produced by the projects.

4. METHODOLOGY

We wanted to uncover the value of the approach we have outlined through a data-led process, using the data collected through the community engagement app and the Our MK initiative to explore the strengths and weaknesses of our approach to involving citizens as participants in smart city initiatives.

An inductive open coding approach was used to examine the meanings embedded within the data sets [Corbin and Straus, 2008]. The dialogues and ideas were subjected to a line-by-line analysis in which concepts were identified and labelled within the data. These codes were subsequently categorised into emerging themes.

No codes or themes existed prior to the analysis; they were created through constant comparison of the data and the application of labels to the text. At the end of the analysis, each dialogue and idea was associated with a single code for each theme.

Beginning with the dialogues collected through the Community Engagement app, our first step was to distinguish between those that referred to "Smart City" topics and those that were related to other Community Mobiliser activities. This was done by examining whether each dialogue related to a community concern or raised an idea that a) related to a specific area of the city, and b) could be addressed using some form of technology or data. The non-related dialogues clearly related to the CMs' other outreach work. For example, "*Suggested solar paths which get sunlight during daytime and light up when people use them at night. Could also monitor footprints to see where people are travelling*" was considered a Smart City topic, whereas a dialogue like the following "*Resident said he was very pleased with his financial situation as a pensioner. He said that he feels well looked-after and that the benefits he is receiving mean that he can live comfortably and not worry about finances*" was categorised as relating to the general work of the Community Mobilisers. The identification of Smart City dialogues was done through a process of inductive open coding by the first author, resulting in a set of 1,516 dialogues (of the original 4,504) that were categorised as related to Smart Cities.

From this set of 1,516 dialogues, 47 distinct codes were established, condensed into 3 key themes. These cover the topic of discussion, the locality of the dialogue, and use of technology. These themes help us examine how useful the dialogues are in identifying community problems.

In order to ensure that these codes could be consistently applied across the data, a series of statistical tests were performed for inter-rater agreement [Tinsley and Weiss, 2000]. Based on the recommendations in Lombard et al., [2002], 25% of the full data set (1,126 dialogues) was selected randomly and subsequently coded by two independent coders. To ensure that the selection of Smart/non-Smart dialogues was reliable, this distinction was also used as a theme. Cohen's kappa was calculated for each theme to assess the level of inter-rater agreement [Lombard et al., 2002]. The results of these tests were near perfect agreement (all Kappas > 0.941 at $p<0.001$) indicating the relevance of the themes to the data and a correct assessment of which dialogues related to Smart City concerns [Landis and Koch, 1977]. All disagreements between coders were adjusted through conversation between the two coders.

The same method of open inductive coding was applied to the ideas from the ideation and innovation initiative. The first author iteratively considered and rearranged the grouping of the ideas, establishing 37 distinct codes, each representing a different facet of the idea. These codes were condensed into 4 key themes covering the nature of the idea, the use of technology within the idea, the scale at which the idea operated, and the reason the citizen could not implement the idea. The themes were checked for inter-rater agreement with a second coder, displaying satisfactory agreement (all Kappas > 0.884 at $p<0.001$). All disagreements between coders were resolved through conversation between the two independent coders.

5. RESULTS AND ANALYSIS

This section reports on the results of the open coding performed on our data. First, we present an analysis of our demographic data, which indicates that we successfully engaged with the socially disadvantaged communities of the city. We then go on to explore the topics of the dialogues and ideas, the scale of the problems and ideas, and

citizens' use of technology within their ideas. These themes were emergent from the data and help us examine how successful we were in engaging citizens as innovators in making their city smarter.

5.1 Demographics

For each of the three elements of the process (dialogue interlocutors, registered users of the Our MK platform, and 'project leaders', the person from the community leading on a project) we have a considerable amount of demographic information (though not always complete).

The precise demographic information for each person involved in each of the dialogues was not always available as notes were not always complete (for age, gender or location).

Focussing first on socio-economic deprivation, the local authority uses a measure called the "Index of Multiple Deprivation" to rank neighbourhoods in the city from the most socio-economically deprived (rank 1) to the least deprived (rank 111) to provide an indication of socio-economic status. Table 1 plots these ranks against where the dialogues were recorded, highlighting that of the 1,358 dialogues with locations noted, 1,247 are associated with the more socio-economically deprived areas of the city[5] with only 111 dialogues recorded in more affluent areas. 219 of the dialogues are from areas within the 10% most deprived areas in England[6]. This is unsurprising given that, by their remit, the majority of CAMK's work takes place within socio-economically deprived areas.

Table 1. Breakdown of the dialogue locations. Locations in *italics* **contain areas within the most 10% deprived areas in England[6]**

Location	Number of Dialogues	Milton Keynes Index of Multiple Deprivation Rank
Beanhill	218	1
Netherfield	128	2
Tinkers Bridge	36	3
Lakes Estate	55	8
Conniburrow	93	10
Ashland	5	11
Fishermead	127	13
Stantonbury	90	18
Bletchley	48	20
Woughton	70	23
Bradville	106	26
Great Linford Parish	126	33
West Bletchley	145	34
Broughton Gate & Brooklands	81	68
Tattenhoe Park	30	91
Total	**1358**	

Using the same ranking of socio-economically deprived areas of the city, we can examine the home locations of the 235 registered users of the ideation platform for

[5] https://www.milton-keynes.gov.uk/your-council-and-elections/statistics/index-of-deprivation
[6] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

whom we have location data. Rather than provide an exhaustive list of these locations (there are 73 in total), we separate them into thirds on the basis of socio-economic data. First, 118 of the users live in areas that are within the third most deprived in the city (9 of these people are within the 10% most deprived areas in England[6]). Then, 59 reside in areas within the middle third, and 58 are from the final third, which comprises the least deprived areas. This highlights that while our membership is across the city, participation is somewhat stronger in the more deprived areas of the city.

Considering the project-leaders, of the 11 who live in the city, 6 live in areas within the lowest third of socio-economically deprived areas of the city (with 1 of these areas being within the 10% most deprived areas in England[6]). Four live in areas within the middle third; one lives in an area within the least deprived areas. This again highlights that our projects are operating in the more deprived areas of the city.

In terms of gender, 918 of the dialogue interlocutors were female, 486 were male. While we have no gender information about the ideation platform participants, 7 of the project leaders are male, and 6 are female. Table 2 shows the age-range of participants in each of the initiatives.

Table 2. Age range of participants

Age Range	Dialogue participants	Ideation platform participants	Project Leaders
Under 5	1		
12-18	188		
19-25	72	17	
26-40	770	132	6
41-59		128	4
60+	303	42	3

As part of the sign-up process for the ideation platform, we also asked participants why they wanted to be involved in the initiative and what their backgrounds are. Out of the 82 responses, 58 indicated they had a community motivation, stating things like "*improving where I live*" and "*I love Milton Keynes as a place to live. I am a volunteer and I like to think I can put something back into our community*". In contrast, only 11 people had technological motivations such as "*studying IOT and this would be a practical use of it*". Similarly, all of the 9 project leaders who responded stated that they had community motivations "*to support and encourage local action that will lead towards more sustainable lifestyles*".

These results are positive as they demonstrate that our process of supporting citizen innovation has successfully involved members from the socially disadvantaged communities of the city and also has a different gender balance compared to those found in hackathons, which are typically attended by technically skilled young men [Decker et al., 2015; Richard et al., 2015].

5.2 Topics

From analysing the dialogues, ideas and projects, 5 topics emerged which are present in each of the data sets. We will discuss these in turn before discussing the various topics that were not present in all three data sets. Cross-tabulations of the data shows that topics were not associated with particular neighbourhoods.

Transport

Transport was the most discussed topic in all three data sets. There were 354 dialogues covering a range of transport topics. The biggest concern focussed on the frequency and route of buses (92 dialogues, e.g. "*No buses through the estate at all now. Stopped the service 12 months ago and now has to go further if they want to catch a bus but can't as they can't walk far*"). This was a significant concern; with the design of the city favouring car users, the routing of existing buses was limiting access to various services for people without cars.

Safety was a major concern (64 dialogues) with people concerned about the speed of drivers (e.g. "*Cars drive too fast down Countess Way. very unsafe*") and the lighting on the cycle path network reducing use (e.g. "*Don't feel safe on [cycle paths] because of the lighting*"). Similarly, maintenance of road surfaces was a major concern for drivers, cyclists and walkers (32 dialogues, e.g. "*Resident told us potholes are terrible on the estate*").

The remaining dialogues cover the practicalities of using various means of transportation (96 dialogues, ranging from difficulties in parking cars to the difficulties of putting buggies on buses) or focussed on new ways of improving transportation in the city (70 dialogues, e.g. "*setting up a community car share scheme for people to do their shopping*").

The ideas from the ideation platform mirror many of these concerns. Seven ideas focussed on improving the public transport situation in the city by planning routes in a more data-driven fashion, providing better data on timetables and introducing apps to make using busses simpler. A further seven ideas consisted of reducing car use either through better data (route busyness or parking locations) or by instituting car reduction schemes (such as car-less areas). Three ideas aimed at making the transport system more accessible for people of different abilities, particularly the visually impaired. Finally, nine ideas referred to the cycle paths network, the major concerns being route planning and navigation although expanding the network, tracking use and problem reporting were also discussed.

This focus on the cycle path network is sustained in the projects, with three of the funded projects focussed on improving them. These projects are based around 1) providing a gamified treasure-hunt to encourage families to use the cycle paths; 2) recording videos of key routes to generate novel navigational tools; and 3) creating an app which streamlines the reporting of difficulties on the cycle paths (e.g. broken glass).

At the time of writing, the gamified treasure-hunt project has finished its pilot. Using geo-fencing technology within a mobile phone app, the project created a treasure hunt competition for primary aged children and their families to take part in. Focussed on the area around Campbell Park, a large public park in Milton Keynes, fifteen geo-locations were created which, when walked through, grant points to the user and present some challenges to gain additional points. The family and school with the most points at the end of the project won a prize. The pilot was run over October 2016 half term, themed around Halloween. 131 active participants (49 adults and 82 children) took part with user comments suggested the game format and topic were fun and engaging. 43% of survey respondents stated that using the game increased their use of the cycle paths with 57% stating it made no difference. Based on the pilot, the project team have decided to purchase a yearly license to continue using the app and use the treasure hunts to encourage use of the cycle path network.

The problem-reporting app has been successfully developed and tested. The city council did not want to integrate the app into their reporting system, being concerned

that an increase in problem reporting with no increase in resourcing could lead to reputational difficulties. As such, the project leader is working with two local parish councils to explore whether they want to support the app and recruit teams of volunteers to address concerns reported within their parish.

The video recording of key cycle path routes continues with three major routes recorded and posted online. The project leader is continuing to work on generating the videos and exploring who might find the videos useful.

Rubbish and Landscaping

294 of the dialogues were related to the physical environment within communities. 142 of these reported on incidents of fly-tipping, littering and dog faeces causing concern to residents (e.g. "*[name] told us that every week there is fly tipping incidents at [neighbourhood]*"). One of the estates took matters into their own hands and organised a clean-up day with 55 dialogues reporting on the positive impact the day made (e.g. "*it was a very good initiative and she hoped more local residents would care about their neighbourhood more*"). With a broader perspective on neighbourhood appearance, 97 dialogues reported on landscaping issues within their area. 58 of these were regarding citizen-led schemes to beautify the area (e.g. "*St Mary's church planters group explained that they had received donations of top soil and bulbs to plant the planters at [neighbourhood]*") with 26 focussing on the council failing to maintain the local green spaces (e.g. "*trees which are knocked down and destroyed along the verges by the teams of grass cutters are not replaced*").

This theme was present on the ideation platform through five ideas focussed on recycling such as tackling waste through to holding a recycling competition between different neighbourhoods and 4 ideas around redesigning the built environment.

One of the funded projects was based around promoting the sale and use of recycled and upcycled furniture, achieved through visiting economically poor communities with an electric-vehicle pop-up shop showcasing the stock of furniture the social enterprise has. By raising the profile of the enterprise, the pop-up shop led to an additional 700kg of furniture being donated. Additionally, the project led to the social enterprise developing contacts in local communities and helped develop a better understanding of the customer base.

Energy and Water

240 dialogues referred to resource sustainability with 4 sub-themes. The first of these focuses on discussions around personal activities to better utilise resources (47 water dialogues, 40 energy dialogues, e.g. "*Idea for every shower to have a timer and a limit. If you go over 10 minutes it will cut out*"). The second sub-theme follows this up with educational campaigns to ensure wide-spread adoption of the idea (33 water dialogues, 35 energy dialogues, e.g. "*Resident suggested that Friends of the Earth were calculating water footprint of products. It would be good to have labelling on all products.*"). The third sub-theme is concepts for institutional change, utilising either government or community organisations to reduce consumption (33 water dialogues, 39 energy dialogues, e.g. "*all newly built houses should have solar panels… including council-owned properties*"). The final sub-theme emerged from the energy dialogues and highlights the difficulties people living in rental properties have when it comes to installing energy-efficiency mechanisms (13 energy dialogues, e.g. "*She has very little power to make [the landlord] fix her house up so saving energy is made more difficult*").

These themes were continued in the ideas we received from the ideation platform. While institutional change and education campaigns were both present, the largest set of ideas (11) concerned encouraging residents to generate their own electricity through various means.

This concern with personal responsibility was carried over into the projects we supported. Focussing on energy, we funded a scheme to promote a low-cost system for off-grid solar lighting. The system is designed around a small number of solar panels charging a low-cost caravan battery. Such a system is about promoting and fostering a sense of independence and resilience rather than saving large amounts of money. This project became one of the pilot projects for the Community Action Platform for Energy[7], an initiative exploring whether processed overhead imagery can assist communities and city councils in reducing energy consumption.

In terms of water, we funded a project focussed on the possibility of watering a large allotment site (around 200 plots, approximately 11 acres) from a water borehole. Unfortunately the geology of the site meant that drilling a borehole would not provide sufficient water.

We also funded a project around fuel poverty in a neighbourhood that is among the most deprived areas in England (lowest 10%). By purchasing blankets to distribute to residents, we are assisting the residents' association with the collection of fine-grained data around levels of fuel poverty and access to digital services. The residents' association hopes to use this data to influence the regeneration of their local area.

Food

Regarding food, there were two main sub-themes in the dialogue data. The first was the popularity of a local foodbank (52 dialogues, e.g. "*[organiser] was very pleased with how the first session of the foodbank went and that she was confident it would make a big difference to many people*"). The second was the creation and popularisation of a community cooking group to teach people how to cook and bring the community together (45 dialogues, e.g. "*he really appreciated the fact that the Cooking group gave him new ideas on how to cook healthy meals that are not expensive*"). One dialogue focussed on the creation of an Urban Farm.

In contrast, the 11 ideas we gathered focussed much more on food sustainability in the form of using locally grown produce. This theme was carried through in one of the food projects we supported. This was based around a 'Food Passport', which included descriptions and addresses of local food outlets and details of independent food events. In return for purchasing a passport, retailers listed in the passport offered a 10% discount to shoppers. All 100 passports produced by the project were sold. The culmination of the Food Passport scheme was a local food festival, supported by 25 local food and artisan sellers, and saw a footfall of over 3,000 visitors.

The second food-related project we funded is a local cooperative who are attempting to reduce non-recyclable packaging waste by offering bulk purchase of dry goods (such as pasta) in re-usable containers. Data was collected from customers regarding their shopping behaviours. The average customer estimated a 55% reduction in their food-related plastic waste and all surveyed customers plan on continuing to use the shop. The project leader estimated that the project has saved over 1000 pieces of plastic going into landfill.

[7] https://capeproject.co.uk

Health

While health was not raised as a concern from within our dialogue data, it was present in the ideas from the ideation platform with eight health ideas based around promoting physical exercise, connecting together health data and promoting wellbeing.

Our main health project is based around creating an app to promote breastfeeding within the city. Alongside detailed information resources, the app will also include a map detailing the best locations in the city to breastfeed. The app will allow users to leave their own reviews about the location as a place to breastfeed.

Inclusion

Inclusion (114) referred to dialogues concerned about bringing different demographics together to create a shared community. This included inter-generational (31 dialogues, e.g. "*saw social isolation as a big problem and thought that some intergenerational work could help solve the problem*"), migrants (53 dialogues, e.g. "*she doesn't really know anyone locally, so doesn't feel like part of the community. She feels this may be to do with being Lithuanian*"), people with disabilities (13 dialogues, e.g. "*complained about the lack of adjustments on the estate that would allow easy access to public places for disabled children*") and the homeless (17 dialogues, e.g. "*she needed more volunteers for Help Our Homeless [city] as the group's activities have been expanding*").

While no ideas on Our MK explicitly refer to inclusion, we have funded two projects that involve some element of inclusion. The first focussed on the needs of older people. Run in conjunction with Age UK, the largest age-related charity in the UK, the aim of the project is to develop a map of Milton Keynes augmented with navigational and social data of interest to the elderly. The hope is that such a map would reduce social isolation amongst the elderly. Created through a series of workshops with older people, the charity is lobbying to include elements of the age-friendly map into a new 3D map being produced by the city council.

The second inclusion project focusses on indoor navigation for blind and visually impaired people. Led by a volunteer for the Royal National Institute of Blind People (RNIB), the project focussed on the challenges of navigating within large, complex indoor spaces. In Milton Keynes, the main shopping centre is completely indoors which poses many navigational issues for visually impaired people. Through a demonstration of a smartphone app utilising Bluetooth-beacons installed across the indoor space, the management of the shopping centre have agreed to the installation of a test area for beacons, to assess their suitability for their upcoming digital strategy. They have also committed to involving visually impaired people in the testing of the digital strategy once it is released.

Additional Dialogue Topics

Two additional topics were present in the dialogue data, but which were not present in the idea or project data – Crime (341) and Politics (75).

The second most discussed topic was crime with the main concern being a fear of crime and a desire for a larger police presence (160 dialogues, e.g. "*Police need to keep an eye out more. Would be nice to see them walking around a bit more*"). This was closely followed by a large set of dialogues discussing anti-social behaviour (122 dialogues, e.g. "*the community garden was seriously vandalised on Saturday with one of the oak benches being totally destroyed*"). Nevertheless, 59 of the dialogues report on the speaker feeling safe in their community.

The final theme regards politics. The majority of the dialogues refer to concerns relating to the regeneration of several areas of the city (65 dialogues, e.g "*Local resident, who is a councillor and a facilitator of many local groups told [us] that a number of local residents he has been talking are very worried about the impact of the [regeneration project]. They are worried that they will lose their homes*"). The remaining 10 dialogues record a feeling that local politics is not representative and that local officials are not accountable enough to residents (10 dialogues, e.g. "*No individual working on behalf of the community should be focusing on personal interests or objectives*").

The final project we supported cuts across all of these topics as it focussed on teaching adults and children computer literacy skills by using the Raspberry Pi. Based on the idea that too few adults have a basic understanding of computer literacy, the project first piloted a community workshop before working with a local school to develop a program of 6 workshops for their STEM club. The project leader is now working with the National Museum of Computing to explore how to take the lessons learnt from running these workshops into a more sustained program of workshops.

5.3 Locality of the Dialogues, Ideas and Projects

In examining the locality embedded within the dialogues, it becomes clear that the majority of the dialogues refer to a community level (716 dialogues) with equal numbers discussing individual circumstances (400 dialogues) and city-wide concerns (400).

Table 3 shows a breakdown of the locality of the dialogues by topic. This highlights that the energy and water topics are somewhat different to the others. While the majority of topics are more focussed on community level and individual concerns, these two topics – which aren't immediately apparent in day-to-day life – become discussed in a more abstract, city-wide manner.

Table 3. Distribution of localities across dialogue topic themes

Topic	Community	Individual	City-Wide	Total
Transport	142	53	159	354
Crime	198	117	26	341
Rubbish	233	43	18	294
Energy	18	40	69	127
Water	0	16	97	113
Inclusion	41	55	18	114
Food	44	53	1	98
Politics	40	23	12	75
Total	716	400	400	1516

In contrast, when studying the distribution of ideas, it appears the majority operated on a city-wide level (50 ideas, e.g. installing air pollution monitors across the city). The second set of ideas referred to community level initiatives (21 ideas, e.g. setting up a community car service) with the third set of ideas operating at the level of individual buildings (13 ideas, e.g. installing a navigation system for partially-sighted people in the main city shopping centre). The remaining 2 ideas concerned the development of a product (e.g. an ecological beer bottle).

In terms of the projects, we had actively selected schemes likely to generate a large amount of social benefit. It is thus unsurprising that the majority of ideas are looking to affect city-wide change or take-up (8 projects, e.g. the food passport

scheme). The other 5 ideas are more tightly focussed around particular communities (5 projects, e.g. the digital pop-up shop).

5.4 Use of Technology

When examining the level of technology within the dialogues that propose an idea, we found that the majority (356 out of 399) involved no technology (e.g. "*Have a daily allocation of water to show people how much they should be using daily*"). Of the 43 ideas utilising technology, 29 involved installing standard technology (e.g. "*Suggested supplying electric bikes for people to use to travel*") while only 14 involved the creation of a new data driven service (e.g. "*Ability to report water leaks/increased people doing this, awareness increased. Making up a map of the water system and showing where water is leaking*").

This pattern is also present within the set of ideas submitted to the Our MK platform, 48% of which involved no technology (39 ideas, e.g. converting a central reservation into a cycle path).

A second set of ideas focused on using existing data or technology (22 ideas), the majority of which involved installing solar panels or water infrastructure (13 ideas). The remaining ideas focused on installing infrastructure around the cycle path network such as digital signage (5 ideas) or using existing data to create a new app or website (4 ideas, e.g. creating a consolidated bus timetable).

The third set of ideas involved the creation or sourcing of new data (25 ideas). These ideas involved the creation of a new app involving a single source of data (18 ideas, e.g. a map indicating real-time availability of parking slots with electric vehicle charging capability) or the creation of new data-driven organisations or services (7 ideas, e.g. a competition to reduce household waste by comparing communities against one another).

As one of the criteria for funding a project was technological innovation, all of the projects involve some form of technology either hardware (e.g. the domestic solar installation) or data-based (e.g. the breastfeeding app).

6. PROJECT EXPERIENCES

Having examined the themes that emerged from a detailed analysis of the dialogues and ideas, we now turn our attention to the projects themselves.

We have previously outlined how the projects came about. To reiterate, we ran four rounds of a funding competition. During each round, the competition was widely advertised and potential applicants could come and meet us at a variety of face-to-face events. The guidelines offered online were:

"*We are offering awards of up to £5,000 for groups of citizens to develop technology-centred ideas which might have an impact on issues of sustainability around Milton Keynes. In addition to the funding, we can also provide help with technical support and advice on running community projects. The deadline for applications is [date]. Project ideas needed to involve some form of digital technology and must be based around the key issues of Energy, Water, Transport, Health and the Environment. Entry to the competition is free. While individual citizens can apply, we would prefer to receive applications from groups to demonstrate wide support for the idea. We are happy for projects to involve making a profit.*"

If the potential applicant thought their project fitted within the guidelines of the competition, they completed and submitted a four-page application form covering

who they were, what their project idea was, how it would affect Milton Keynes, a short budget and an outline plan for sustaining the project beyond the end of the Our MK initiative (if applicable). Projects could apply for up to £5000 and last up to 18 months. Over the 4 rounds of the competition, 28 project applications for funding were submitted, of which 13 were funded. The average length of an application was 3,477 words.

The decision of which projects to fund was made collectively by the three partners involved in Our MK (The Open University, CAMK and Graymatter) on the basis of cost/benefit, community need, technical innovation and relevance to the concept of being a Smart City. The agreed costs ranged between £300 and £5000 (*Mean* = £2743, *SD* = £1553).

Once a project was agreed to be funded, a contract letter was drawn up by the Open University, outlining the terms and conditions associated with the award and guaranteeing the release of funds. This generally consisted of ensuring Our MK branding was included on marketing materials and that any data generated by the project was released under a creative commons license.

Each project was provided with one-to-one support by a designated member of Community Action: MK who acted as a contact point for questions and could keep the rest of the team up-to-date with the progress of the project. The first author of this paper took a broader perspective, overseeing each of the projects at a high level. On occasion, we utilised our connections with different organisations to link the projects with other types of expertise (such as the cycle path team at the city council) to seek advice and guidance. Our ongoing support for the projects has included opportunities to develop their projects through networking opportunities and assisting with applications for further funding.

At the end of each project the CAMK contact produced a report detailing the contact they have had with the project and their understanding of what has changed in local communities as a result of the project. Additionally, each project provides us with a report of what has gone on within the project (using a template examining the running of the project, the impact it has generated and plans for the future). Finally, each project leader was interviewed to explore their experience of applying to Our MK and running a project. While many of the projects are ongoing, our formal involvement in them has now finished and all 13 project leaders have been interviewed. 12 of the interviews were audio recorded and transcribed with the 13th preferring to have someone taking notes. The interviews lasted between 30 to 67 minutes (*Mean* = 48 minutes).

An inductive open coding approach was used to examine the content of the reports and transcripts [Corbin and Straus, 2008]. The reports and transcripts were subjected to a line-by-line analysis in which concepts were identified and labelled within the data. These codes were subsequently categorised into emerging themes. This process was led by the first author who had contact with each of the projects. No codes or themes existed prior to the analysis; they were created through constant comparison of the data and the application of labels to the text.

6.1 Results

The themes from the analysis can be grouped into three broad categories. The first refers to *the success the individual projects have had*; the second to *elements of the Our MK initiative which worked well*; the third highlighted *areas of improvement*. In this section we discuss what the interviews reveal about the successes and weaknesses of the Our MK initiative before combining our analyses and discussing

the challenges and opportunities of large-scale urban PD our experiences have revealed. (The success of the completed projects was presented alongside the project descriptions in Subsection 5.2.) Quotes are identified by a random interview identifier unrelated to the project ID to protect interviewee confidentiality.

Successful Elements of Our MK

The first thing to note is that all except one of the 13 project leaders we interviewed stated that, given the opportunity, they would apply to the Our MK scheme again and would also recommend it to other people. This provides some indication that the scheme worked. The one exception stated that she had struggled too much with the bureaucracy related to the initiative.

Of greater interest is what elements of the Our MK initiative made it successful. The first element is *motivation*. When exploring what motivated the project leaders it became clear that each of the individuals recognised a clear problem and wanted to do something to address it (e.g. "*I have always wanted [this] system here, you see… and I thought oh, we could apply for funding from this*" [P1]). Such motivations fitted with what the project leaders perceived as the aims of the Our MK initiative: "*I think its about citizen empowerment which was really, that was really what I took from it, I felt that somebody trusted me as a person, gave me some money to make a change in the city that I live in…*" [P5].

The other significant element of the initiative was the degree of personal contact the projects had with their CAMK contact and the Open University. The enthusiasm of the team (e.g. "*enthusiastic… it wasn't, you were back and forward a lot making sure things were right… everyone was really enthusiastic and nice about it which was good*" [P2]) and the commitment from members of the team to make the projects a success had a significant impact on how each of the projects operated (e.g. "*you guys were very supportive and you always kept in touch, and if there was any need, anything like an invoice needs to be sent or something, there's always someone at the end of the phone who's always very helpful and very keen to help*" [P3] and "*the guys that have been running it and managing it have done a very good job"* [P4]).

Areas for Our MK to Improve

The most notable area to improve was in the *bureaucracy* related to each of the projects. Project leaders first experienced this in the drawing up of the award letter (which acts as the contract between the academic partner and the project leader and allows the release of funds). Being a large institution with fiduciary responsibilities, the academic partner has a set of processes for preparing contracts, and these processes require a significant amount of time. It took, on average, 75 working days (minimum 23 days, maximum 117 days) to draw up an award letter. The treasure hunt on the cycle path network app took 117 working days to confirm due to complex concerns around child protection. This was very frustrating to project leaders who, having been awarded the funding, wanted to move forward and start creating change in their communities: "*I think there were some problems in terms of organisation; the main one was that I applied in August, mid August I think it was, and by the time we were trying to Launch at the beginning of November, the paperwork still hadn't been signed*" [P5]; "*I think the only slight constraint is timeframe… because we had to spend the money by the end of the year, it forced us to deliver it in a time that wasn't the best*" [P6]. These delays continued throughout the projects with the University's purchasing system proving to be slower and more complex than the project leaders expected. Note that this concern is not intended as a criticism of the academic

partner but serves to highlight the importance of expectation management so that project leaders do not become unnecessarily frustrated with necessary paperwork.

The second area for improvement revolved around the expertise that project leaders could draw upon. Whilst the Our MK team had technical and community engagement expertise, we had a limited amount of time that could be dedicated to any one project. Particularly with the more sophisticated technology-focussed projects, we did not have time to do the development work ourselves and struggled to recruit volunteers to help with the development of software for some of the projects, particularly the breastfeeding app. This was a significant barrier that slowed down the pace of those projects.

When asked what additional expertise Our MK could have provided, four of the project leaders noted in their interviews that assistance with promotional materials would have been useful. In both cases the projects wanted to try and engage with a large number of people across the city, something that is challenging without substantial marketing expertise. The initiative lacked "*someone who could have helped me to write a press release and has good really good connections to the local press because I tried to connect with them to get articles in there and they weren't really having any of it*" [P5]. Such a shortcoming likely reduced the scale of success the projects could have potentially reached. While the Our MK initiative as a whole successfully engaged people across the city, we did not have sufficient resourcing, or expertise in marketing, to assist the individual projects with their marketing and public engagement. This was an oversight of how the initiative was constructed, something that should be addressed in similar projects where more resources are allocated to supporting the projects beyond the injection of capital.

7. DISCUSSION, CHALLENGES AND OPPORTUNITIES

Taking the two distinct analyses together, our results show how our process has empowered socially disadvantaged communities, with the data demonstrating a clear connection across the different stages of the process from problems to ideas to projects on similar concerns.

Considering the data as a whole, our contributors focussed on things that they experience every day. The set of topics highlights how people regard "green" issues in a broad manner. The ideas they produce are intensely practical, providing solutions that would work right now to alleviate current problems. There were no blue-sky ideas intended to solve longer-term issues within the city.

Our analysis of the different data sets also shows how different approaches to engagement provide input at different levels of locality. The face-to-face approach taken to generating dialogues provided problems particularly related to the local; the online approach utilised by the ideation platform generates more generic ideas; the face-to-face approach taken for the projects once again makes the change more embedded within local communities.

These results stand in marked contrast to some of the hyperbole surrounding the Smart City agenda. Many such projects have stated aims that are somewhat grandiose and self-congratulatory without considering the views and needs of the citizenry [Hollands, 2008]. While there is space for such long-term thinking, it needs to be coupled with a consideration of short-term needs.

Our results show that the prevailing rhetoric around Smart Cities is somewhat disconnected from the grounded concerns of socially disadvantaged communities. We argue that by integrating a large-scale, systematic approach to facilitating citizen

innovation within the city, communities become empowered to address concerns or lobby for changes that address the problems they are facing today.

7.1 Barriers to Citizen Innovation

One of the limitations we identified from the literature on crowdsourcing ideas (e.g. [Schuurman et al., 2012]) or gathering polling information on particular ideas (e.g. [Taylor et al., 2012]) is that, without action from a third party, the citizen's contribution is wasted. Such an argument is supported by our data, which highlights a number of barriers preventing citizens from actioning their ideas by themselves. First, many ideas involved collaborating with either the council or companies to utilise their physical infrastructure (40 ideas, e.g. setting up a 'park & ride' scheme) or data (5 ideas, e.g. encouraging recycling through competition). While the city council has consultation mechanisms to gather feedback on clear proposals, there is no procedure for citizens to propose new ideas and no commitment from the council or companies to listen to or enact such proposals.

Second, some of the proposals are so costly that only government (local or national) would be able to cover the costs (5 ideas, e.g. interest-free loans for the installation of solar panels). Others are achievable but necessitate a level of investment that some community groups struggle to develop (17 ideas, e.g. installing solar panels on a community building).

Third, many of the proposals require technical skills not held by the originator of the idea, with 10 of the ideas only achievable with the right technical skills (e.g. developing an app for finding a walk or bike ride which fulfils user-set criteria). This may be particularly the case with our demographic, with the digital divide continuing to be of concern, particular with reports highlighting the link between digital and social exclusion [Helsper, 2008].

This means that, of the 86 ideas the ideation and innovation initiative generated, only 9 ideas were achievable by the users themselves without some form of assistance. This is not surprising as most change involves collaboration. To some extent, this was the purpose of the Our MK initiative, to provide a package of support to projects which would otherwise never be achieved.

The approach we have proposed and undertaken thus brings two advantages. Recognising the progression from identifying problems, to generating ideas, to developing projects which in turn need to move forwards, we have designed an integrated program which allows a citizen to engage, participate and progress through the multiple stages of the innovation process. We suggest that such an integrated process is needed, particularly within our target demographic, to overcome the barriers we have identified that prevent citizens actioning their ideas without support.

The second advantage we bring is from being part of a broader Smart City consortium. This brings a commitment to take citizen innovation seriously from the various stakeholders in the project. This both amplifies the voice of ordinary citizens in a manner not possible by support from researchers alone but also creates collaborations, ensuring that citizens can draw on the expertise necessary to make their ideas into viable projects.

7.2 Balancing Scale with the Personal

Previous work in digital civics has highlighted the importance of forming personal connections and social networks beyond any technical implementation [Hansen et al., 2014; Farnham et al., 2012; Hui et al., 2014]. Our experience has shown the same

thing; while ideas have been crowdsourced online, both the collection of dialogues and much of the project support has relied on face-to-face contact.

This creates a challenge when attempting to scale up participation. While we have engaged a substantial number of people, we have at best engaged around 18,000 people, with 4,000 engaged by the community mobilisers, 500 attending face-to-face events, and over 13,000 visiting the Our MK website. Given that the population of Milton Keynes is around 230,000, this remains a small proportion of the overall citizenry.

This is important as one aim of citizen-led innovation is to give all citizens the ability to be involved in the design of systems that will affect their daily lives. As others have argued, the selection of participants for research projects is a political matter that can privilege social groups who can more easily contribute and who already have relevant competencies and values [Vines et al., 2013]. We need to be mindful of who is involved and in what capacity, ensuring that we are conscious of unknown users and their characteristics [Gidlund, 2012]. While we have demonstrated it is possible to engage socially disadvantaged communities, city-scale projects need to ensure that they are open to engagement from all sectors of the population. We have little data regarding how to engage other demographics but our experiences appear to indicate that, to be successful, a city needs a set of distinct initiatives targeting different demographics that involve a different form of participation from different sectors of the citizenry. However, while this helps achieve scale and demographic diversity, it runs the risk of emphasising the differences between communities rather than creating a set of interlinking policies that unify the city. Furthermore, the identification of concerns through the dialogues only becomes meaningful once a critical mass is collected, allowing large-scale analysis to explore the underlying concerns. Once at a large scale, the dialogues can then be used to alert city officials to the things that actually matter to people.

Achieving scale whilst retaining personal connections is challenging [Hansen et al., 2014]. We have demonstrated the value of a balanced approach, utilising both online tools and face-to-face contact. While this has worked well, scaling participation rates to tens of thousands of people without losing their personal stories calls for reflection on our current experiences.

One lesson we have learnt is the need to refine the narrative of what the initiatives are attempting to achieve. During face-to-face conversations, this is easier as the story can develop as the conversation progresses. Online, however, we found that it was challenging to convey the complex and multifaceted nature of our initiative to prospective participants. In particular, detailing the ideation and innovation initiative, its intended purpose, its relationship to the city and the Smart City project, how people can get involved, and what the limitations of the scheme are, were all key issues that needed to be packaged into a coherent message for site visitors. We recommend supplementing online activities with face-to-face events, such that it is possible to retain the benefits of personal connections whilst utilising the online platform to achieve scale.

7.3 Control of the Process

PD researchers have previously noted the complexity of power distribution and decision-making in PD projects [Bratteteig and Wagner, 2012; Robertson and Wagner, 2013]. “At the core of PD there is the ambition that users should take part in all types of decisions – also in the big decisions, like defining the problem and its solution – and be given a voice, as well as the power to participate in the decision-

making" [Bratteteig and Wagner, 2012, p. 41]. They go on to argue that this power can be actioned in a variety of ways (based on [Borum and Enderud, 1981]) including "agenda control (what is discussed and who decides the themes), participants (who are invited in), scope (which solutions are possible – and hence, which problems are defined and seen as relevant and therefore addressed), and resources (available time and people)" [Bratteteig and Wagner, 2012, p. 47].

One of the shortcomings of other work with citizens in the field of Smart Cities is that the citizen tends to have an essentially passive role. As far as possible, across our work with citizens, we have attempted to release power and control to citizens, particularly project leaders. Unfortunately, the regulations for the grant that funded our research mandate that the decision of which projects to fund, and control of those funds, must remain with the academic partner. As such, there is a disjoint between our goals of community empowerment and who, ultimately, retains control. This may lead to difficulties as institutions do not always have the flexibility and agility required to support motivated citizen groups to achieve their goals, as evidenced by the time delays our initiative encountered in getting award letters approved and expenses paid in a timely manner.

Furthermore, under the criteria laid out in the description of work, only certain types of projects could be funded by the Our MK initiative. These constraints placed another layer of control onto the research team, and this is arguably undesirable; we received project applications that would clearly create a large amount of social benefit but, under the rules laid down, could not be funded because they did include a sufficiently technological focus. For example, we had a project application from a new community centre that wanted to install solar panels on their roof. Approximately 400 people a week across a wide variety of community groups use the centre and running the building on renewable energy would be an excellent use of resources. However, this was not considered to be "smart" enough, leading us to fund other projects that tended to have smaller social benefits. This is reflective of the smart city agenda, which tends towards technosolutionism, i.e. reaching for technological solutions to issues rather than considering broader socio-political change [Lindtner et al., 2016]. We accept this critique to the extent that, being funded through a Smart City project, we have tended to seek solutions that utilise some form of technology or data. However, we should note that while we were constrained by our funding remit of supporting technologically-based community projects, all of these projects created social benefit.

Alternative models can be envisaged, particularly an approach more heavily based on crowdsourcing where the competition for funding is judged solely by the response of the community. There are three clear concerns with this approach; the first is financial probity whereby research funders are unlikely to release funds to community initiatives without some assessment of whether the funding is going to be spent responsibly. The second concern is whether community decision-making is an effective way of making decisions; if such decisions become essentially a popularity contest, initiatives from larger well-known groups are likely to be more popular than schemes from more marginalised communities that may produce a greater social benefit. Throughout our work we have been keen to amplify quiet voices from communities that are often overlooked; crowdsourcing the decision-making process is likely to continue to exclude these marginalised groups. The final concern is the role of the research team. As noted by others (e.g. [Johnson et al., 2016]) in such PD projects, there is a balance between ensuring the research team's expertise is utilised whilst not taking over complete control of the process. In a crowd-sourced decision

making approach, the research team's expertise is removed from the decision-making process and is only drawn upon to operate in what could be flawed projects if the crowd has decided to fund projects with significant flaws.

We cannot proffer a solution to this challenge but as the scale of PD projects grows, questions of control and power become increasingly stark. We thus raise it as an ongoing challenge for the future of the methodology, which is particularly pertinent when operating at an urban scale.

7.4 Who is Participating?

Some researchers have argued that we should focus more on outcomes rather than participation when considering participatory design processes [Whittle, 2004]. In the context of a city, outcomes are hard to determine amongst a large, diverse set of stakeholders. Therefore, strong participation is needed to ensure we are not biased towards including certain populations and to address community concerns from across the entire city.

Identifying who can legitimately participate may be straightforward in small projects; in large complex settings, it becomes more problematic [Robertson and Wagner, 2013]. Furthermore, not everybody has the resources (in terms of time or capital) to take part. "Defining those who may have the 'right to participate' is made difficult by constraining forces – political power, organisation and professional boundaries" [Robertson and Wagner, 2013]. As we noted earlier, civic participation tends to be strongest amongst those with high levels of education, income and socioeconomic status [Kavanaugh et al., 2005]. This, by its very nature, makes it harder to engage with and empower certain communities and groups of people.

As highlighted by the feminist HCI agenda, we should be looking at breaking down institutionalised preconceptions about what citizens need and support them in shaping their own solutions [Bardzell and Bardzell, 2011]. Our approach has done this by rejecting the top-down management of many Smart City projects in favour of an approach that empowers communities and citizens to run their own projects that embody their own values. While we have structured our engagement approach in a particular way, which embodies the values of the research team, we note in section 8 the biases this has raised and the impact this has had on the research outcomes.

Our demographic data shows that, with the right kind of support, middle-aged adults in lower socio-economic communities can be engaged and empowered to innovate in this manner in the context of Smart Cities. This was likely due to this being the demographic Community Action:MK have the best links with. This highlights that it is possible to facilitate civic participation amongst this specific population.

However, in directing our efforts to recruiting and engaging this community, we did not place a strong focus on engaging with other marginalised groups such as the elderly, people with disabilities or mental health difficulties, immigrants and transient populations or the young. Equally we did not focus on engaging with other more affluent groups who have economic resources but are perhaps time-poor; nor did we manage to engage individuals with technical skills. Further work is needed to explore whether other groups can be supported in the way we have supported participation from the lower socio-economic communities in Milton Keynes.

As Gidlund notes, determining who qualifies as being a citizen and finding those citizens interested in participating is a non-trivial task [Gidlund, 2012]. In our experience it is difficult, if not impossible, to design a recruitment approach which gains an equal interest from the multitude of communities and stakeholders from

within a city. This then raises the idea of designing a multi-faceted approach to PD at scale with each city deploying a loose confederation of initiatives, each with the shared goal of empowerment but involving different degrees of participation from different target populations.

7.5 Integrating Citizen-led Work into Local Authorities

One of the key stakeholders in any city is the local authority, the political organisation responsible for the functioning of key city services (which, for example, can include transportation, education and refuse collection).

The introduction of design practices into local authorities, and the public sector in general, remains in its infancy. "Design knowledge is still far from having entered public organizations on a large scale, affecting daily processes and underlying culture" [Deserti and Rizzo, 2014, p. 89]. Furthermore, "most of the changes obtained through the new practices are thus affecting the superficial level, while at deeper levels the established culture, mindset, habits, and practices are still dominant" [Deserti and Rizzo, 2014, p. 86]. This lack of grounding in design approaches is apparent across many elements of the smart city agenda with legislation often being a barrier to innovation [Goldsmith and Crawford, 2014]. Harding et al. [2015] observe that the perceived value and sustained use of technologies for civic engagement has remained low. They argue that prior work has been, perhaps surprisingly, too citizen-centred, and has failed to account for the needs and concerns of civic authorities whose responsibility it is to ensure the accountability of the produced data [Harding et al., 2015].This is further compounded by the fact that in many countries, key services are not necessarily delivered exclusively by the local authority but by a mixture of public sector, private sector and third sector organisations with unclear boundaries of responsibility. As Weise et al. [2017] argue, it is necessary to account for the variety of actors operating within the civic arena, with questions of ownership and disenfranchisement being politically sensitive.

Attempting to embed citizen-led projects into the local authority landscape is challenging. Municipalities have reputational concerns, which can limit their openness to outside ideas [Robertson and Wagner, 2013; Wagner et al., 2009]. This is likely why many PD projects in public services focus on collaborating with public sector employees rather than members of the public [Bratteteig et al., 2013]. Additionally, the local authority has a responsibility to its citizens. Key services must work, be delivered efficiently and in a context of ever-increasing financial pressure. This naturally leads to a tendency for local authorities to be risk-averse.

During the initial stages of our project we attempted to integrate two of the projects into the city council processes – particularly the app to collect problems on the cycle path network and recording videos of key cycle path routes. While CAMK have excellent links with certain parts of the council, in both of these projects the level of engagement from the council was low. Regarding the first project, the council were concerned that such an app would increase the number of issues recorded into their database without providing any additional resourcing to accomplish the repairs, potentially damaging the council's reputation. In terms of the video project, we simply could not find anyone at the council who was interested in the idea. Based on these experiences, we made a conscious decision to run the Our MK initiative as a complement to the council's activities rather than something that would generate activities the council might want to support.

Similarly, the ideas collected through the Our MK initiative generated a substantial set of possibilities for improving local communities, some of which are on

a scale that only the local authority could implement. One of the shortcomings of our current approach is the lack of activity based on these ideas – while some were proposed by individuals who were happy to develop them into projects and thus action on the ground, the majority were proposed by citizens who did not want to commit to turning them into projects, leaving these ideas languishing, with the local authority lacking the financial resources to monitor, assess or consider actioning any of the proposed ideas[8]. Sustainable development and smart cities are not statutory services for a local authority in the UK. This makes it very challenging to engage with projects that do not have a clear business case, irrespective of their perceived social benefits.

The challenge for urban-scale Participatory Design is thus deciding how far to attempt to involve the local authority. The trade-off is that although the local authority is unlikely to be entirely open to the outcomes from the design activities, they hold the key to sustaining and scaling the result of the design process in the long-term. This trade-off is likely to remain for the foreseeable future until such a time that local authorities become more flexible and willing to tolerate failure.

8. REFLECTIONS AND LIMITATIONS

Reflecting on what we have achieved through our work on Our MK, there are a number of areas that were less successful than we hoped. The first is around empowerment. One of our critiques of commercially led Smart City programs is that they tend to treat citizens as consumers. We hoped that empowering citizens would act as a complementary counterpoint, giving a voice and a degree of power to citizens. Our intention was not to replace national or city level institutional activities but to supplement them with small-scale changes that directly impacted issues which may be unique to a community. This was somewhat successful with the projects primarily being run by dynamic individuals representing some form of community organisation. While we could have worked directly with established community groups, opening participation to anyone allowed us to empower a broader section of the community.

One of the issues with this empowerment was the intransigence that project leaders experienced from working with, amongst others, the city council. This reiterates how current political structures are risk averse, inflexible, and generally resistant to citizen-led proposals (at least in the UK). These factors are predominantly due to huge financial cuts to the local authority, meaning that the city council can only focus on the delivery of vital services. Changing the nature of these political structures is beyond research projects such as ours. Working within the current political structure we would thus argue that individual empowerment is an essential element of urban design (certainly within Smart City programs), not as a replacement to state-backed activity but rather as a complementary form of action that ensures citizen- and community-level ideas can be enacted.

The second area for reflection is the influence the funding body and formation of the consortium had on the outcomes of the project. The smart city focus of the MK:Smart backdrop undoubtedly constrained the nature of the projects we could support. We consciously decided to have a broad interpretation of what we would consider to be "smart" and prioritised the social benefit of a proposed project over the technological innovation. Even so, as we have previously noted, there were projects we had to reject due to falling outside of our remit. Noting that this was less than

[8] https://www.milton-keynes.gov.uk/pressreleases/2015/dec/milton-keynes-council-announces-draft-budget-proposals

ideal, we had decided to try and mitigate this issue by directing such projects to work with the funding team at CAMK, who are experts in finding funding for charitable and community groups. Furthermore, the structure of the funding limited the amount of control we could release to citizens. While frustrating for some of our project leaders, both the research team and the project leaders all recognised that this was simply one of the practicalities of being funded as a research project. In future work we hope to explore alternative funding models which we hope will allow us to redress the balance of control in the citizens' favour.

In terms of the consortium, there are biases and opportunities that arose on two levels. In the formation of the partners for the citizen innovation work package, the Open University provided administrative and technical expertise while CAMK lead the majority of the outreach work. This led to a series of implicit biases regarding the format our engagement took. For example, our approach towards engagement was shaped by CAMK's pre-existing approach to engagement, the nature of the demographic we approached was biased towards those communities CAMK had established links with, and the nature of the projects we supported was biased towards those with strong technical elements, as assessed by the university. Such unconscious biases would likely have been present regardless of the partners involved. More broadly, being part of a large consortium funded by HEFCE, and which included businesses and the city council, the MK:Smart project was biased towards economic growth as that was the rationale underpinning the project as a whole. As a research team, we had to consciously disregard this default position when considering the needs of our citizen innovation work and focus on what would benefit local communities. However, being part of the broader consortium led to a large degree of access, particularly at the city council, as well as in commercial organisations both within and beyond the consortium that the citizens on their own would have struggled to establish. While the results of that access were somewhat mixed, the access would not have occurred without our presence in the consortium. Given that involvement with the consortium did not compromise our ability to run the citizen innovation work package the way the research team wanted to, there was little downside from the organisational structure.

There are of course some limitations to our work, and these are worth outlining to place our results in context. The first, quite simply, is cost. While crowdsourcing ideas involves little expense, the face-to-face contact and resources needed by the projects were expensive. This is one of the reasons why exploring the balance between scale and personal connections is so important, in order to establish how to achieve large-scale participation whilst keeping the costs manageable.

Our model was designed to limit the input of the research team in the early stages of problem identification and idea solicitation, relying on the online platform to scaffold the solicitation of ideas. With a finite amount of time available, we decided to focus on supporting project leaders. While this assisted with scale (evidenced through the number of dialogues and ideas gathered compared to the number of projects supported), this did limit a more open-ended innovation approach with ideas co-created between citizens and the research team. We worked heavily with the project leaders in shaping their proposals, yet we did not have the capability to do this with everyone who identified a problem or proposed an idea. In future programs that use an approach similar to ours, we would encourage research teams to supplement the tailored support provided to funded projects with public events akin to hackathons focussed on developing comprehensive proposals to addressing community problems. Such an event could stimulate more open-ended thinking by bringing together

diverse groups of citizens, without requiring an open-ended commitment from the research team.

Throughout this paper we have used the projects to highlight similarities across the first three stages of our process. We have some initial evidence that these projects are starting to create social benefits within the communities in which they are embedded. We also have initial indicators that some of the projects will continue to develop; for example, the breastfeeding app is likely to be sustained in the long term due to interest from a local health provider. In future work we plan to explore how the projects have created sustainable change in more detail.

We also need to note that all of the work contained within this paper comes from a smart city project based in a medium sized city (population ~230,000) in the UK. The research was thus completed in a particular technical, social, political and cultural context. As such, we have no means of testing how accurate our challenges and opportunities are for cities in other contexts (e.g. in different countries or continents) or at different sizes – working in Milton Keynes is likely to be very different to working in Tokyo (population: ~13,000,000)[9]. This suggests that sharing the results from our work and encouraging others to replicate them internationally would assist in building a set of best practices for large-scale urban PD.

9. CONCLUSION AND FURTHER WORK

Creating a Smart City necessitates harnessing the knowledge, creativity and innovativeness of its citizens. However, to date, there have been few attempts to achieve this at an urban scale. Having contributed an approach designed to facilitate citizen-innovation, at scale, within a Smart City project, we provide empirical insights into the benefits of engaging with socially disadvantaged citizens in this context. Our insights lead us to conclude that benefits and impact can be achieved through an integrated approach of online and offline activities, bridging all stages of the innovation process such that *problems*, *ideas*, *projects* and *sustaining success* are achieved in such a way that actually addresses citizens' current concerns. Our PD process should not be seen as a homogenous, immutable policy approach but as one with locality-specific forms and trajectories. We argue that our approach is a starting point for building a set of best practices for developing inclusive Smart City projects.

Beyond this we have reflected on the challenges we faced when attempting to utilise participatory design activities at an urban scale. We have identified four key challenges: balancing scale with the personal, who has control of the process, who is participating, and integrating citizen-led work into local authority activities. While the approach we have presented takes a position on each of these issues, we do not have sufficient data to argue strongly for a position on any of them. We thus highlight these four areas as grand opportunities for further work to establish best practice when trying to invoke PD methods at an urban scale. Only by exploring these opportunities and addressing the challenges can we truly engage citizens as collaborators in co-designing their city.

ACKNOWLEDGMENTS

The authors would like to thank everybody in Milton Keynes who has taken part in any of our engagement activities, particularly the project leaders for their hard work, dedication and commitment. This work has

[9] http://www.metro.tokyo.jp/ENGLISH/ABOUT/HISTORY/history03.htm

been undertaken as part of MK:Smart which is part funded by the UK Higher Education Funding Council for England (HEFCE).

REFERENCES

Esteve Almirall, Melissa Lee, and Jonathan Wareham, 2012. Mapping living labs in the landscape of innovation methodologies. Technology Innovation Management Review, 2(9).

Tuba Bakıcı, Esteve Almirall, and Jonathan Wareham, 2013. A smart city initiative: the case of Barcelona. Journal of the Knowledge Economy, 4(2), pp. 135-148.

Mara Balestrini, Tomas Diez, Paul Marshall, Alexander Gluhak and Yvonne Rogers. 2015. IoT Community Technologies: Leaving Users to Their Own Devices or Orchestration of Engagement? EAI Endorsed Transactions on Internet of Things 15(1). DOI= http://dx.doi.org/10.4108/eai.26-10-2015.150601

Shaowen Bardzell and Jeffrey Bardzell. 2011. Towards a feminist HCI methodology: social science, feminism, and HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '11). ACM, New York, NY, USA, 675-684. DOI: https://doi.org/10.1145/1978942.1979041

Moritz Behrens, Nina Valkanova, Ava Fatah gen. Schieck, and Duncan P. Brumby. 2014. Smart Citizen Sentiment Dashboard: A Case Study Into Media Architectural Interfaces. In Proceedings of The International Symposium on Pervasive Displays (PerDis '14), Sven Gehring (Ed.). ACM, New York, NY, USA, 19-24. DOI=http://dx.doi.org/10.1145/2611009.2611036

Karim Benouaret, Raman Valliyur-Ramalingam, and François Charoy, 2013. CrowdSC: Building Smart Cities with Large-Scale Citizen Participation. Internet Computing, IEEE, 17(6), 57-63.

Birgitta Bergvall-Kåreborn and Anna Ståhlbrost. 2008. Participatory design: one step back or two steps forward?. In *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008* (PDC '08). Indiana University, Indianapolis, IN, USA, 102-111.

Devis Bianchini, Daniela Fogli, and Davide Ragazzi. 2016. Promoting Citizen Participation through Gamification. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (NordiCHI '16). ACM, New York, NY, USA, , Article 8 , 4 pages. DOI: http://dx.doi.org/10.1145/2971485.2971543

Erling Björgvinsson, Pelle Ehn, and Per-Anders Hillgren. 2010. Participatory design and "democratizing innovation". In Proceedings of the 11th Biennial Participatory Design Conference (PDC '10). ACM, New York, NY, USA, 41-50. DOI=http://dx.doi.org/10.1145/1900441.1900448

Kirsten Boehner and Carl DiSalvo. 2016. Data, Design and Civics: An Exploratory Study of Civic Tech. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 2970-2981. DOI=http://dx.doi.org/10.1145/2858036.2858326

F. Borum and H. Enderud, 1981. Konflikter i organisationer, Nyt Nordisk Forlag Arnold Busck, Copenhagen

Andrea Botero and Joanna Saad-Sulonen. 2008. Co-designing for new city-citizen interaction possibilities: weaving prototypes and interventions in the design and development of Urban Mediator. In Proceedings of the Tenth Anniversary Conference on Participatory Design 2008 (PDC '08). Indiana University, Indianapolis, IN, USA, 266-269.

Andrea Botero and Joanna Saad-Sulonen. 2010. Enhancing citizenship: the role of in-between infrastructures. In Proceedings of the 11th Biennial Participatory Design Conference (PDC '10). ACM, New York, NY, USA, 81-90. DOI=http://dx.doi.org/10.1145/1900441.1900453

Bryan Boyer and Dan Hill, 2012. Brickstarter. Sitra. Available from http://www.lulu.com/shop/dan-hill-and-bryan-boyer/brickstarter/paperback/product-21067017.html

Tone Bratteteig, Keld Bødker, Yvonne Dittrich, Preben Holst Mogensen, and Jesper Simonsen, 2013. *Organising principles and general guidelines for Participatory Design Projects*. The Handbook of Participatory Design, edited by J. Simonsen and T. Robertson pp. 117-144. Routledge, New York.

Tone Bratteteig and Ina Wagner. 2012. Disentangling power and decision-making in participatory design. In *Proceedings of the 12th Participatory Design Conference: Research Papers - Volume 1* (PDC '12), Kim Halskov, Heike Winschiers-Theophilus, Yanki Lee, Jesper Simonsen, and Keld Bødker (Eds.), Vol. 1. ACM, New York, NY, USA, 41-50. DOI=http://dx.doi.org/10.1145/2347635.2347642

Erik Braun, Leo van den Berg and Jan van der Meer, eds. National Policy Responses to Urban Challenges in Europe. Ashgate Publishing, Ltd., 2012. Harvard.

British Standards Institute, 2014. Smart city framework – Guide customer service to establishing strategies for smart cities and communities. PAS 181:2014, ISBN 978 0 580 81856 1. Accessed from http://www.bsigroup.com/en-GB/smart-cities/Smart-Cities-Standards-and-Publication/PAS-181-smart-cities-framework/

Andrea Caragliu, Chiara Del Bo, and Peter Nijkamp, 2011. Smart cities in Europe. Journal of urban technology, 18(2), 65-82.

Fabio Carrera, Stephen Guerin, and Joshua Thorp, 2013. By the people, for the people: the crowdsourcing of "streetbump": an automatic pothole mapping app. *ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XL-4/W1* pp. 19-23.

John M. Carroll and Mary Beth Rosson, 2007. Participatory design in community informatics. Design Studies, 28(3), pp. 243-261.

Chesbrough, H. Open Innovation. The New Imperative for Creating and Profiting from Technology. Harvard: Harvard Business School Press, 2003.

Hafedh Chourabi, Taewoo Nam, Shawn Walker, J. Ramon Gil-Garcia, Sehl Mellouli, Karine Nahon, Theresa A. Pardo, Hans Jochen Scholl, 2012. Understanding smart cities: An integrative framework. In System Science (HICSS), 2012 45th Hawaii International Conference on (pp. 2289-2297). IEEE.

Andrew Clement and Peter Van den Besselaar, 1993. A retrospective look at PD projects. *Communications of the ACM* 36(6): 29-37.

Tanguy Coenen, Shenja van der Graaf, and Nils Walravens Coenen, 2014. Firing Up the City-A Smart City Living Lab Methodology. Interdisciplinary Studies Journal, 3(4), pp. 118 - 128. Accessed from https://www.laurea.fi/dokumentit/Documents/ISJ_vol%203_no%204_web_Smart%20Cities.pdf

Grazia Concilio, 2016. Urban Living Labs: Opportunities in and for Planning. In Concilio, G. and Rizzo, F., ed., *Human Smart Cities* pp. 21-40. Springer International Publishing.

Juliet Corbin and Anselm Straus. 2008. Basics of qualitative research. Sage, London, UK.

Ayona Datta, 2015. New urban utopias of postcolonial India 'Entrepreneurial urbanization'in Dholera smart city, Gujarat. *Dialogues in Human Geography* 5(1), pp. 3-22.

Alessandro Deserti, 2016. Design and the Transformation of Cities. In Concilio, G. and Rizzo, F., ed., *Human Smart Cities*, pp. 63-79. Springer International Publishing.

Adrienne Decker, Kurt Eiselt, and Kimberly Voll, 2015. Understanding and improving the culture of hackathons: Think global hack local. In Frontiers in Education Conference (FIE), pp. 1-8. IEEE.

Alessandro Deserti and Francesca Rizzo, 2014. Design and Organizational Change in the Public Sector. *Design Management Journal* 9(1): 85-97.

Tomas Diez and Alex Posada. 2013. The fab and the smart city: the use of machines and technology for the city production by its citizens. In Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction (TEI '13). ACM, New York, NY, USA, 447-454. DOI=http://dx.doi.org/10.1145/2460625.2460725

Àlvaro Duarte de Oliveira, 2016. The Human Smart Cities Manifesto: A Global Perspective. In Concilio, G. and Rizzo, F., ed., *Human Smart Cities*, pp. 197-202. Springer International Publishing.

Benoît Dutilleul, Frans Birrer, and Wouter Mensink, 2010. Unpacking European living labs: analysing innovation's social dimensions. Central European journal of public policy, 4(1), pp. 60-85.

Pelle Ehn, 2008. Participation in design things. In *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008* (PDC '08). Indiana University, Indianapolis, IN, USA, 92-101.

ENoLL (2015) ENoLL Website http://www.openlivinglabs.eu/aboutus

Jarmo Eskelinen, Ana Garcia Robles, Ilari Lindy, Jesse Marsh, and Arturo Muente-Kunigami, 2015. Citizen-Driven Innovation. A report from the World Bank and European Network of Living Labs.

Shelly Farnham, David Keyes, Vicky Yuki, and Chris Tugwell. 2012. Puget sound off: fostering youth civic engagement through citizen journalism. In Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work (CSCW '12). ACM, New York, NY, USA, 285-294. DOI=http://dx.doi.org/10.1145/2145204.2145251

Bent Flyvbjerg, 2006. Five misunderstandings about case-study research. Qualitative inquiry, 12(2), 219-245.

Marcus Foth, Martin Tomitsch, Christine Satchell, and M. Hank Haeusler. 2015. From Users to Citizens: Some Thoughts on Designing for Polity and Civics. In Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction (OzCHI '15), Bernd Ploderer, Marcus Carter, Martin Gibbs, Wally Smith, and Frank Vetere (Eds.). ACM, New York, NY, USA, 623-633.

Archon Fung, 2009. Empowered participation: reinventing urban democracy. Princeton University Press.

Katarina L. Gidlund. 2012. Designing for all and no one - practitioners understandings of citizen driven development of public e-services. In Proceedings of the 12th Participatory Design Conference: Research Papers – Volume 1, ACM, New York, NY, USA, 11-19. DOI=http://dx.doi.org/10.1145/2347635.2347638

Stephen Goldsmith and Susan Crawford. 2014. *The Responsive City: Engaging Communities Through Data-Smart Governance*. John Wiley & Sons

Connie Golsteijn, Sarah Gallacher, Lisa Koeman, Lorna Wall, Sami Andberg, Yvonne Rogers, and Licia Capra. 2015. VoxBox: A Tangible Machine that Gathers Opinions from the Public at Events. In Proceedings of the Ninth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '15). ACM, New York, NY, USA, 201-208. DOI=http://dx.doi.org/10.1145/2677199.2680588

Derek L. Hansen, Jes A. Koepfler, Paul T. Jaeger, John C. Bertot, and Tracy Viselli. 2014. Civic action brokering platforms: facilitating local engagement with ACTion Alexandria. In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (CSCW '14). ACM, New York, NY, USA, 1308-1322. DOI=http://dx.doi.org/10.1145/2531602.2531714

Mike Harding, Bran Knowles, Nigel Davies and Mark Rouncefield. 2015. HCI, Civic Engagement & Trust. in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM, 2833- 2842. DOI: 10.1145/2702123.2702255

Ellen Helsper, 2008. Digital inclusion: an analysis of social disadvantage and the information society.

Department for Communities and Local Government.

Hendrik Hielkema and Patrizia Hongisto, 2013. Developing the Helsinki smart city: the role of competitions for open data applications. Journal of the Knowledge Economy, 4(2), pp. 190-204.

Robert G. Hollands, 2008. Will the real smart city please stand up? Intelligent, progressive or entrepreneurial?. City 12(3), pp. 303-320.

Simo Hosio, Vassilis Kostakos, Hannu Kukka, Marko Jurmu, Jukka Riekki and Timo Ojala, 2012. From school food to skate parks in a few clicks: using public displays to bootstrap civic engagement of the young. In Pervasive Computing, pp. 425-442. Springer Berlin Heidelberg.

Julie S. Hui, Michael D. Greenberg, and Elizabeth M. Gerber. 2014. Understanding the role of community in crowdfunding work. In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (CSCW '14). ACM, New York, NY, USA, 62-74. DOI=http://dx.doi.org/10.1145/2531602.2531715

Marijn Janssen, Yannis Charalabidis and Anneke Zuiderwijk, 2012. Benefits, adoption barriers and myths of open data and open government. Information Systems Management, 29(4), pp. 258-268.

Ian G. Johnson, John Vines, Nick Taylor, Edward Jenkins, and Justin Marshall. 2016. Reflections on Deploying Distributed Consultation Technologies with Community Organisations. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 2945-2957. DOI=http://dx.doi.org/10.1145/2858036.2858098

Andrea Kavanaugh, John M. Carroll, Mary Beth Rosson, Debbie D. Reese, and Than T. Zin., 2005. Participating in civil society: the case of networked communities. Interacting with Computers 17(1), pp. 9-33.

Sami Kauppinen, Satu Luojus, and Janne Lahti. 2016. Involving Citizens in Open Innovation Process by Means of Gamification: the Case of WeLive. In *Proceedings of the 9th Nordic Conference on Human-Computer Interaction* (NordiCHI '16). ACM, New York, NY, USA, Article 23 , 4 pages. DOI: http://dx.doi.org/10.1145/2971485.2971526

Rob Kitchin, 2011. The programmable city. Environment and Planning B 38: 945-951

Rob Kitchin. 2014. The real-time city? Big data and smart urbanism. *GeoJournal*, 79 (1). 1-14. DOI: 10.1007/s10708-013-9516-8

Ailsa Kolsaker and Liz Lee-Kelley, 2008. Citizens' attitudes towards e-government and e-governance: a UK study. International Journal of Public Sector Management, 21(7), pp. 723-738.

Travis Kriplean, Jonathan Morgan, Deen Freelon, Alan Borning, and Lance Bennett. 2012. Supporting reflective public thought with considerit. In Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work (CSCW '12). ACM, New York, NY, USA, 265-274. DOI=http://dx.doi.org/10.1145/2145204.2145249

J. Richard Landis and Gary G. Koch, 1977. The measurement of observer agreement for categorical data. Biometrics 33:159-174.

Christopher A. Le Dantec, Mariam Asad, Aditi Misra, and Kari E. Watkins. 2015. Planning with Crowdsourced Data: Rhetoric and Representation in Transportation Planning. In Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15). ACM, New York, NY, USA, 1717-1727. DOI=http://dx.doi.org/10.1145/2675133.2675212

Melissa Lee, Esteve Almirall, and Jonathan Wareham. 2015. Open data and civic apps: first-generation failures, second-generation improvements. Communications of the ACM, 59, 1 (December 2015), 82-89. DOI=http://dx.doi.org/10.1145/2756542

Matt Leighninger, 2011. Citizenship and governance in a wild, wired world: How should citizens and public managers use online tools to improve democracy?. National Civic Review, 100(2), pp. 20-29.

Silvia Lindtner, Shaowen Bardzell, and Jeffrey Bardzell. 2016. Reconstituting the Utopian Vision of Making: HCI After Technosolutionism. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 1390-1402. DOI: https://doi.org/10.1145/2858036.2858506

Matthew Lombard, Jennifer Snyder- Duch, and Cheryl Campanella Bracken, 2002. Content analysis in mass communication: Assessment and reporting of intercoder reliability. Human communication research, 28(4), pp. 587-604.

Donald McMillan, Arvid Engström, Airi Lampinen, and Barry Brown. 2016. Data and the City. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16). ACM, New York, NY, USA, 2933-2944. DOI=http://dx.doi.org/10.1145/2858036.2858434

Taewoo Nam and Theresa A. Pardo. 2011. Conceptualizing smart city with dimensions of technology, people, and institutions. In Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times (dg.o '11). ACM, New York, NY, USA, 282-291. DOI=http://dx.doi.org/10.1145/2037556.2037602

Johanna Nuojua, Leena Soudunsaari, and Helka-Liisa Hentilä. 2010. Boosting web-based public participation in urban planning with a group of key stakeholders. In Proceedings of the 11th Biennial Participatory Design Conference (PDC '10). ACM, New York, NY, USA, 239-242. DOI=http://dx.doi.org/10.1145/1900441.1900491

Anne-Marie Oostveen and Peter Van den Besselaar, 2004. From small scale to large scale user participation: a case study of participatory design in e-government systems. In *Proceedings of the eighth conference on Participatory design: Artful integration: interweaving media, materials and practices - Volume 1*, pp. 173-182. ACM.

Peterborough City Council - Frozen animals. Last accessed March 2016, https://data.gov.uk/dataset/peterborough-city-council-frozen-animals/resource/03635365-29a2-4752-9e50-d68ae50192c2

Danial Qaurooni, Ali Ghazinejad, Inna Kouper, and Hamid Ekbia. 2016. Citizens for Science and Science for Citizens: The View from Participatory Design. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (CHI '16). ACM, New York, NY, USA, 1822-1826. DOI: http://dx.doi.org/10.1145/2858036.2858575

Gabriela T. Richard, Yasmin B. Kafai, Barrie Adleberg, and Orkan Telhan. 2015. StitchFest: Diversifying a College Hackathon to Broaden Participation and Perceptions in Computing. In Proceedings of the 46th ACM Technical Symposium on Computer Science Education (SIGCSE '15). ACM, New York, NY, USA, 114-119. DOI=http://dx.doi.org/10.1145/2676723.2677310

Toni Robertson and Ina Wagner, 2013. Engagement, representation and politics-in-action. *The Handbook of Participatory Design, edited by J. Simonsen and T. Robertson* pp. 64-85. Routledge, New York.

Royal Institution of Chartered Surveyors (RICS), 2017. Smart Cities, Big Data and the Built Environment: What's Required? Accessed from: http://www.rics.org/uk/knowledge/research/research-reports/smart-cities-big-data-and-the-built-environment-whats-required/

Ronald Schroeter. 2012. Engaging new digital locals with interactive urban screens to collaboratively improve the city. In Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work (CSCW '12). ACM, New York, NY, USA, 227-236. DOI=http://dx.doi.org/10.1145/2145204.2145239

Douglas Schuler and Aki Namioka, eds. *Participatory design: Principles and practices*. CRC Press, 1993.

Douglas Schuler, 2016. Smart Cities+ Smart Citizens= Civic Intelligence? In Concilio, G. and Rizzo, F., ed., *Human Smart Cities*, pp. 41-60. Springer International Publishing.

Dimitri Schuurman, 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), pp. 49-62.

Jennifer L. Shirk, Heidi L. Ballard, Candie C. Wilderman, Tina Phillips, Andrea Wiggins, Rebecca Jordan, Ellen McCallie et al., 2012. Public participation in scientific research: a framework for deliberate design. *Ecology and Society* 17(2): 29.

Jesper Simonsen and Morten Hertzum, 2008. Participative design and the challenges of large-scale systems: extending the iterative PD approach. In *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008* (PDC '08). Indiana University, Indianapolis, IN, USA, 1-10.

Alexandra Stiver, Leonor Barroca, Shailey Minocha, Mike Richards and Dave Roberts, 2015. Civic crowdfunding research: Challenges, opportunities, and future agenda. New Media & Society, 17(2), pp. 249-271.

Surowiecki, J. The Wisdom of Crowds. New York: Anchor Books. 2004.

Nick Taylor, Justin Marshall, Alicia Blum-Ross, John Mills, Jon Rogers, Paul Egglestone, David M. Frohlich, Peter Wright, and Patrick Olivier. 2012. Viewpoint: empowering communities with situated voting devices. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '12). ACM, New York, NY, USA, 1361-1370. DOI=http://dx.doi.org/10.1145/2207676.2208594

Sarah-Kristin Thiel. 2016. Reward-based vs. Social Gamification: Exploring Effectiveness of Gamefulness in Public Participation. In Proceedings of the 9th Nordic Conference on Human-Computer Interaction (NordiCHI '16). ACM, New York, NY, USA, DOI: http://dx.doi.org/10.1145/2971485.2996739

Howard EA. Tinsley and David J. Weiss, Interrater Reliability and Agreement. In: Tinsley, H. E., & Brown, S. D. (Eds.). (2000). Handbook of applied multivariate statistics and mathematical modeling. Academic Press.

Anthony M Townsend. 2013. *Smart cities: big data, civic hackers, and the quest for a new utopia*. WW Norton & Company

United Nations, Department of Economic and Social Affairs, Population Division, World Urbanization Prospects The 2014 Revision. http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf

Nina Valkanova, Robert Walter, Andrew Vande Moere, and Jörg Müller. 2014. MyPosition: sparking civic discourse by a public interactive poll visualization. In Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing (CSCW '14). ACM, New York, NY, USA, 1323-1332. DOI=http://dx.doi.org/10.1145/2531602.2531639

Peter Van den Besselaar, 1998. Technology and Democracy, the limits to steering. In Proceedings of the Fifth Conference on Participatory Design 2008 (PDC '98). Seattle, WA, USA, pp. 1-10.

Perrine Vanmeerbeek, Lara Vigneron, Pierre Delvenne, Benedikt Rosskamp and Melanie Antoine, 2015. Involvement of end-users in innovation process: towards a user-driven approach of innovation – A qualitative analysis of 20 Livings Labs. In: Research Day Conference proceedings 2015,

OpenLivingLab Days. European Network of Living Labs, ISBN (e-book): 9789082102741, pp. 79-86. https://www.scribd.com/doc/276089123/ENoLL-Research-Day-Conference-Proceedings-2015

Alberto Vanolo, 2016. Is there anybody out there? The place and role of citizens in tomorrow's smart cities. *Futures* 82, pp. 26–36.

John Vines, Rachel Clarke, Peter Wright, John McCarthy, and Patrick Olivier. 2013. Configuring participation: on how we involve people in design. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13). ACM, New York, NY, USA, 429-438. DOI=http://dx.doi.org/10.1145/2470654.2470716

Ina Wagner, Maria Basile, Lisa Ehrenstrasser, Valérie Maquil, Jean-Jacques Terrin and Mira Wagner, 2009. Supporting community engagement in the city: urban planning in the MR-tent. In *Proceedings of the fourth international conference on Communities and technologies*, pp. 185-194. ACM.

Sebastian Weise, Paul Coulton & Mike Chiasson, 2017. Computer Supported Cooperative Work, 26(4-6), pp. 927-958. https://doi.org/10.1007/s10606-017-9277-x

Jon Whittle. 2014. How much participation is enough?: a comparison of six participatory design projects in terms of outcomes. In Proceedings of the 13th Participatory Design Conference: Research Papers - Volume 1 (PDC '14), Vol. 1. ACM, New York, NY, USA, 121-130. DOI=http://dx.doi.org/10.1145/2661435.2661445

Andrea Wiggins and Kevin Crowston, 2011. From conservation to crowdsourcing: A typology of citizen science. In System Sciences (HICSS), 2011 44th Hawaii International Conference on (pp. 1-10). IEEE.

Received xxxxxx; revised xxxxxxxx; accepted xxxxxxx