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Participatory IoT Policies: A Case Study of Designing Governance at a Local Level

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Abstract: As IoT devices proliferate in public spaces, it is vital that adequate governance structures and policies are designed and implemented in order to enhance trust, and protect privacy and security of citizens. At a local level, smaller towns and cities that are not part of the 'smart city' movement, but instead are connected through IoT devices, also need to consider how these devices are governed. This research explores how two novel methods (design fiction and walkshops) can be combined and embedded in the design of policy for IoT governance at a local level. The contribution of the work lies in wider discussions of design methods in policy making and offers a case study of how these methods can be used at a local level.

Keywords: Design for policy; IoT; Edge Computing; IoT governance

1. Introduction

Today IoT (Internet of Things) devices pervade our towns and cities. Sensors are often used in mundane services, such as waste management, traffic monitoring and air quality management. Exploration of the potential and real impacts of such sensors is often situated within literature pertaining to the smart city, where large scale deployments and real-time data monitoring are embedded. However, IoT devices are now routinely being used at much smaller scales, with sensors providing useful data for governments at a local level.

Recent research (Jacobs et al., 2020a; Jacobs et al., 2020b) has started to explore the implications of deploying IoT sensors at a local scale and making sense of what this means for designing policies around deployment of such systems in public spaces.

The research presented here is located within a wider exploration of how design methods can be used across a range of contexts in the development and implementation of policy. In recent years the question of how design is being applied at different levels of policymaking has become an area of interest within design research (Bason, 2014). The research presented in this paper contributes to the development of this area by offering a case study

of how a particular design method (design fiction) can be used in designing policies for emerging technologies in public places.

This paper presents findings from an eight-month research project that explores participatory policymaking for IoT and Edge Computing in a district council in Lancashire, UK. Using design fiction, we explored potential impacts of a range of public space IoT in order to support evidence-based policy development for ethical and secure deployments in public spaces. We specifically explored the context of local governance at the district level. Through carrying out two walking workshops, in person with council officers, and online with IoT experts, we developed a set of policy recommendations.

In this paper, we present the background to the research and explore the implications and challenges of designing IoT governance at a local level. We then describe the data gathering methods we used and the rationale for choosing them, before presenting the findings from the walks. Finally, we explore the implications of these findings and set out an agenda for future research in this area.

2. Background

2.1 IoT and Governance in England

The need for adequate governance of IoT devices in both private and public settings has been recognised worldwide at international, national and more local levels. Governance models or policies for IoT in public spaces cover regulatory and advisory rules and procedures.

At a local level, governments must ensure they adhere to national information governance standards and employ officers to carry out these regulatory and legal duties. This is managed at the local level by officers within councils, who lead in ensuring the collection and governance of data are managed within the legal frameworks. IoT devices are also governed by wider legislation, but this is often at the domestic level (e.g., smart devices such as fridges, televisions, energy meters) and falls within the privacy by design framework (Jacobs et al, 2020a).

Whilst governments at the local level in England have policies for the gathering, storage and use of data and information, fewer have developed and implemented policies that specifically respond to IoT in public places. Guidance for policymakers at this level is available, through the NCSC's (National Cyber Security Centre) 'Connected Places Cyber Security Principles' and Smart City Standards (NCSC, 2020). The NCSC refer to 'Connected Places' rather than Smart Cities, in recognition that a growing number of locations are becoming connected through use of sensors, but might not consider themselves smart, or may not be a city. This categorisation of places that are connected is useful to this work, as we explore towns and cities that use sensors, but are not part of the smart city paradigm.

The research presented here takes the Principles as guidance, but seeks to explore how the benefits, challenges and issues of a Connected Place are understood by different stakeholders (in this case council officers and IoT experts).

'Public spaces' fall under the remit of a wide array of organisations, both public and private. Therefore, when considering IoT in public spaces, it is important to consider the differing organisations deploying sensors which collect, and in some cases process, data on site. To add to this complex system, within local government (the organisational setting for this research), responsibility for IoT systems is distributed within different departments, including IT, Information Governance, Public Realm, amongst others. At a local level, the nature of local governance in England means that infrastructure within the town or city is often controlled by different agencies. Within a district such as the location for our research for example, roads and highways are under the control of the county council, waste management at the district level, river level monitoring (this is particularly important as the river that runs through the city is liable to flooding) by the Environment Agency.

2.3 Participatory Policymaking

Participatory work has been used to explore the specific area of public space IoT deployments at the local level (Jacobs et al., 2020a; Jacobs et al., 2020b), including the prior work of the Trustlens project. One challenging aspect of considering the introduction of new technologies, particularly regarding the complex and interconnected issues of privacy, trust, ethics and data use, is that potential concerns are often not obvious until the technology is able to be observed in-situ, interacting with people and the environment where the impacts are seen. This leads to uncertainty when solutions are considered at the abstract level, contributing to what is known as the Collingridge Dilemma (Genus et al, 2018). This states that

> "attempting to control a technology is difficult … because during its early stages when it can be controlled, not enough can be known about its harmful social consequences to warrant controlling its development; but by the time these consequences are apparent, control has become costly and slow".

In order to tackle this lack of control, the P-PITEE project explores the use of participatory policy making, where officers within local government can engage with data collection (the walkshops) and in developing the policy.

Within the realm of design research, participatory design is a method that seeks to include stakeholders in the design process as active research participants rather than research subjects, and assumes that knowledge generated by ordinary members of the research context has value and validity, rather than privilege the position of the researcher.

Whilst participatory policymaking is often considered in the context of citizen engagement (Michels and de Graaf, 2010), in this research we explore participation within the district council and its stakeholders, which might be other local governments (e.g., at the county

level), public organisations (e.g., the Environment Agency) or suppliers of IoT devices and systems. The policy developed with the local government will include a stakeholder mapping activity, which will enable officers to identify who should be involved in further iterations of the policy framework.

2.4 Using design (fiction) methods in Policymaking

The use of design methods in policymaking has grown in recent years, being used at local, national and international levels (Bason, 2014). The use of design methods in policymaking enables those involved in the development and implementation of policies to not only envision the possible impacts, but also to engage wider stakeholders who might be affected by the policies.

This research builds upon a previous project, (Trustlens) which explored the potential for citizen participation in the design process of public IoT through using design fiction objects. The use of speculative design and design fiction is of value in understanding the potential impacts of IoT deployments in public spaces as these design approaches are used 'not to show how things will be but to open up a space for discussion' (Dunne and Raby, 2014 p.15). Using prototypes which are physical manifestations of a fictional shift in the world (Jacobs et al, 2020c) the opportunity to explore possible futures can be explored with a range of stakeholders. Little has been written in literature about how design fiction can be used in policymaking processes, even though it is being used in public policy making in the UK Government, within the UK Policy Lab, where a Speculative Designer is employed (Miller, 2019).

The aim of using design fiction in this research is to enable policymakers and stakeholders to imagine possible futures. This is especially important in this realm of policymaking, in order to explore not only potential issues and threats that result from deploying IoT devices, but also in identifying possible benefits from using these technologies. Furthermore, IoT devices tend to be 'hidden in plain sight' (Cottrill et al, 2020), with sensors placed in locations not easily observed by passing citizens. Therefore, in this research we use design methods to bring the devices, both real and imagined, to the fore and to enable a range of people to interrogate them.

3. Methods

3.1 IoT in the City Walking Workshops

The first walk took place in the city of Lancaster and we invited officers from the district council. Participants were recruited through a council officer who also works on the wider research project, who was specifically asked to invite staff who would be interested in understanding more about IoT sensors in the city centre.

Fig.1 Field Guide provided for participants for both walks

Each site of interest on the walk was the location of a sensor deployment. Some of these, were real objects in the urban environment. However, others were created as design fictions. We produced a Field Guide for IoT in the City, which participants were asked to fill in at each stop. They were asked the same questions at each stop:

1. Guess what the sensor is
2. Consider what data the sensor collects and why
3. Benefits of the system
4. Risks of the system
5. Challenges (ethical/security) to the system

Stickers were provided between questions 2 and 3 which gave the participants more information about each device (beyond what could be observed, such as data management details) and marked them as 'True' or 'False', according to whether each device actually existed as part of a real deployment, or whether it was a design fiction. The aim of the guide was to encourage participants to engage in thinking through the different questions and to record this for our research purposes.

Some of the stops (such as the real air quality monitoring station, and the fictional traffic counting bollard) had no signage or information to inform about the function of the device. Others included information signage, which again might include a range of level of detail

about the function and data collection, or ways in which the data are used and processed. The design fiction objects were developed to provide both a range of transparency levels, and also a range in terms of the ethical and privacy questions raised by their supposed function.

Fig.2 Example of signage provided at each of the 8 stops on the walk

The symbols on the signs were an amalgamation of existing signage, including from the previous Trustlens project, new material, and the symbols created for a research project exploring legibility of AI design (Lindley et al, 2020). The signs all employed different visual languages to represent the different types that might be used where different sensors or processing devices are owned by different organisations.

The second walk was held virtually, using the Gather Town digital platform (Fig.3) and participants were IoT experts. The virtual platform was used partly to open the activity to a wider geographic range of participants, and partly due to COVID-19 travel restrictions. Participants were recruited through two subject specific mailing lists and through publicising the activity via our research project blog. This walk used the same locations as the physical walk, and to enable participants to see the objects, we inserted short videos of the location which also showed the signage at each stop.

4. IoT in the City Walks: Findings

4.1 Prior understanding of IoT systems and design principles

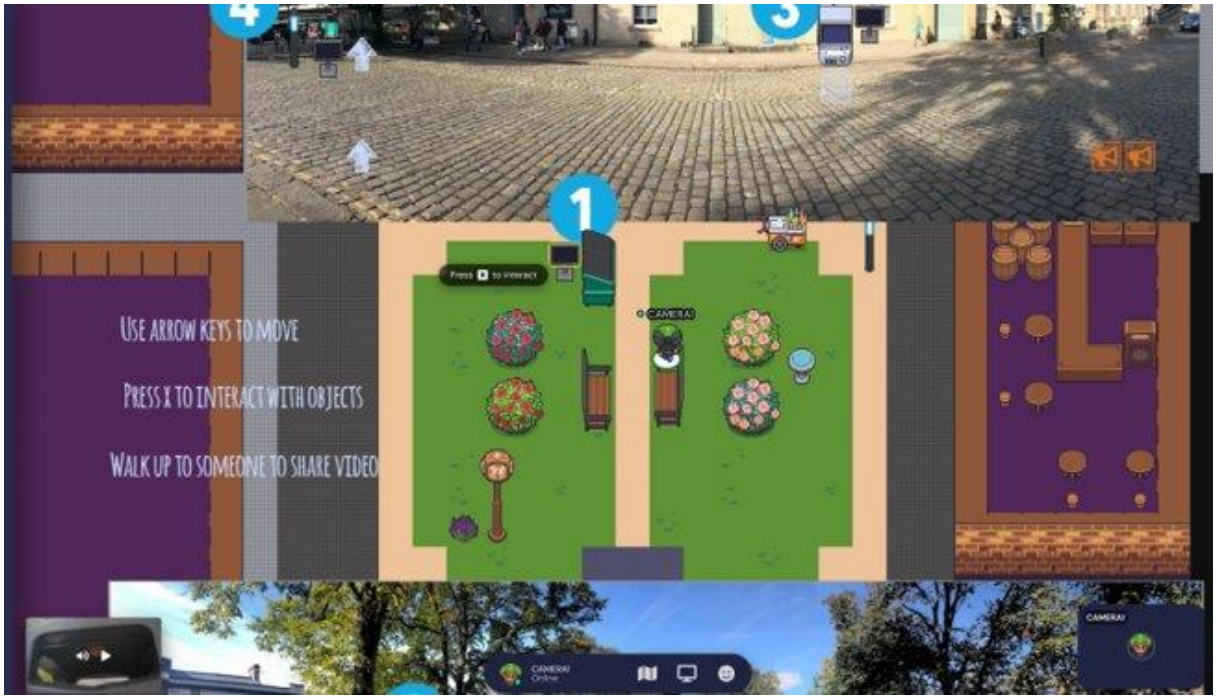

Fig.3 Image of the virtual walk carried out using the Gather Town platform

Whilst the participants of the first walking workshop were engaged in the walk and locality, their understandings of IoT was minimal. One participant encountered use of sensors in the department they oversaw, but others had not engaged with sensors in their daily work. This did not pose issues, as participants were open to learning about the devices, but it highlighted the need for greater awareness of how such systems come to be placed in the public realm and the implications for security and privacy.

The participant who was familiar with using sensors works in the public realm and has been instrumental in the implementation of smart bins. These sensors have been rolled out around the district and use a sensor for fill level and motion detection. The other participants were not familiar with these existing deployments. Conversations between participants about the potential uses for the sensors and additional functionality brough to light the lack of co-ordination across the council and beyond (for example at County level).

The NCSC Connected Places principles offer a useful framework for local governments who are designing and implementing IoT systems. However, we found that the principles have not been widely distributed, and officers we spoke to in the council were not aware of them. We also found that the ownership of the policy itself was limited to one officer within the council, who left their role shortly before the end of this project. This highlights the need for

ownership of policies in this domain, which is not wholly covered by legislation, across organisations.

4.2 Complicated governance structures of public place IoT systems

The implementation of IoT and Edge devices around the city are managed by a range of public and private organisations, depending upon their responsibilities. These include, for example, the County Council who are responsible for highways and public transport, Environment Agency who are responsible for weather monitoring and monitoring of the river that runs through the city, the district council for air quality, refuse collection and parking. There is currently no co-ordinated map of sensor locations available to all district council officers, or that is shared between public and private organisations. During the walk the group discussed the potential benefits of having such a census, as it would enable them to share data and explore possible partnerships or uses of the sensors and/or the data that are collected.

One participant, representing Tourism, stated that having access to various sensors or the data gathered relating to foot-fall and flow through the city would enhance their understanding of visitors throughout the city. There are significant challenges in sharing data, particularly relating to privacy, but by enabling the relevant organisations to see where sensors are located and have access to a shared map, greater transparency and collaboration can be fostered. This approach could also identify doubling up and repetition of device deployment.

4.3 Communication of IoT devices

As noted above, a variety of signage was included as part of the design fictions. We deliberately designed signs to look different, in order to represent the myriad organisations who could own or operate the devices in public spaces (Fig.2). If more IoT devices are to be introduced into public spaces, it is important that those designing policies consider whether visual information should communicate both the device function and the types of data being gathered in a clear manner.

Some of the signs included symbols (after Lindley et al, 2020) representing information such as the different uses of the data being gathered, the use of AI in processing data externally (e.g., data that are collected and then processed beyond the device, as opposed to edge technologies, where the data are processed internally) and whether the data would be used for prediction purposes (e.g., the use of video and physical gait analysis to predict whether a person might behave in a particular way). We found that participants were unclear as to what the symbols on the signs represented. During the city walk with council officers, they were unclear as to what terms such as ‘processing’ meant in relation to the data being gathered.

Whilst the symbols are clear representations visually, we found that the references to the processes of gathering and processing data were not clear. This lack of clarity in the visual

language was also captured in the virtual walk, where participants commented upon the language used on the symbols, stating that it might be difficult for a citizen to understand what 'external processing', or 'prediction' means. Although the symbols represent a fictional standardised system, no such system yet exists. There is a need for wider communication of what IoT sensors are being used for in public spaces, both within organisations and in the wider public. Without this, symbols and visual communication will be meaningless to those who do not have an understanding of the sensors that are deployed, the data they gather and how it is processed.

4.4 Challenges and threats to IoT systems in public places

We found that responses to challenges and threats of the specific IoT devices shown to participants varied amongst the council officers and IoT specialists. The physical threats to the devices or the objects they are mounted on or in were identified by officers, such as bins being set alight or knocked over, or sensors being tampered with or vandalised. Where the data itself was considered as being at risk, the council officers identified issues such as 'data protection', 'data use and management' or 'data loss'. The IoT specialists identified more detailed risks, such as 'false negatives', 'there is always a risk of a side channel or man in the middle attack on such a system', 'sensors could get covered or pick up false info and trigger false alerts'.

Issues around digital exclusion were also identified by both groups when asked about possible risks. Where mobile devices are required to check in (for example with the cafe stop which used the existing NHSX QR code), or the parking meter which enabled the use of mobile devices to provide additional information, such as the movements of the citizen, or the bus station which used mobile data, participants questioned how those without mobile devices could utilise these services. This is vital to consider, as those without mobile devices are locked out of using services, or having their data collected (which might be seen by some as a positive element of not owning a device).

5. Discussion

5.1 Public trust in IoT devices

The district council's information governance and data protection policy covers data and information that are provided in a range of ways. In terms of public space, the only data collection covered by the policy, and by legislation, are images captured by the CCTV cameras in the public realm. However, as we see in the findings (above), the potential of introducing more invasive sensors into the city poses more significant challenges for local government. On both walks participants were concerned about the ways in which data were collected and where consent was procured. They were also concerned with potential breaches of data storage, whether directly from the sensors, or from council-run systems. We also found a complex array of organisations who are responsible for the gathering of

data from different sensors, such as at a county level and through private organisations. This constellation of sensors poses challenges for governance *across* organisations, where a range of data are gathered as citizens carry out their lives in the city.

5.2 Gaps between legislation and principles for good practice

We found that the use of design fictions enabled us to create a space for discussion about potential benefits and challenges of introducing IoT into public spaces. As the walks progressed, we found that participants, particularly the council officers who did not have an in depth understanding of IoT, built knowledge and became more open to exploring the possible futures of the objects we presented. The act of moving through a space, whether physically, or virtually, offers opportunities for participants to build knowledge, not only from the surroundings and the prompts provided by the facilitators, but also from one another (Mullagh, 2021).

Ownership and design of policies across organisations who have interest in IoT systems in public spaces is important. As we found in this research, where smaller cities and towns are not engaging in large-scale 'smart' or 'connected' spaces, there is often a lack of joined-up working. In Lancaster we found that there is not a complete picture of IoT sensors and devices around the city, as responsibility lies across a range of organisations. This issue was also found during the first walk. Therefore, one of the key policy areas suggested will enable officers to develop a more detailed picture of what sensors are currently located within the city, and how these might cause risks or enable collaboration among the organisations.

5.4 Reflections on designing the policy

The use of speculative design and design fiction in the development of policymaking is a nascent area, with few case studies where it has been explored. We found that encouraging participants to identify what the object was and the ways in which it collected data opened up conversations between the groups. We also found that as the walks progressed, participants became more confident in guessing not only what the object was, but the potential benefits, risks and threats to the systems. Designing the signage for the objects around the city gave us the opportunity to explore levels of transparency and observe where a lack of transparency led to assumptions about or mistrust of the deployment.

The first stage of the city walks (both in-person and virtual) offered us, as researchers, valuable insights into the ways in which participants responded to the fictional objects. When combined with the expert interview with DCMS, literature and existing guidelines and principles for IoT in public spaces, the data collected from the walks offered a rich, qualitative component to the research. This has enabled us to develop policy areas that will be presented at a workshop with key council officers in the near future (see Fig.1 for the policy design process).

As a short research project (eight months), that was conducted during the COVID-19 pandemic, P-PITEE was somewhat limited in the number of walks we were able to conduct. Bringing together key council officers (from the district council and county councils), IoT experts, other organisations and members of the public would enable us to gather a wider and richer data set. However, this was not possible due to time and project constraints. As Mullagh (2021) points out, bringing people, or a public, together around a specific challenge (in this case IoT devices in public spaces) through walking, can bring out hitherto un-considered aspects and enable participants to develop and create knowledge on the move. Even within the project constraints, we were able to garner valuable insights that have formed the basis of a policy for the district council and officers have informed us that the walks have sparked new conversations between them and changed the way they think about sensing in the city. The work has also enabled us to reflect upon the potential for using design fictions in policymaking at a local level and to understand the benefits and challenges of this method. We found that using the term 'design fiction' to officers did not immediately aid their understanding of the process we were using. However, when going through the process of exploring the objects and when asked to consider what 'might be', rather than 'what is', and when prompted in conjunction with the signage placed on objects, participants understood the process and engaged in speculating the various aspects of the systems.

5.5 Implications for policy

From the research carried out thus far, we have identified areas that will be included in policy recommendations. The next stage will involve the development of policy areas *with* council officers at an interactive workshop. We will present key areas of policy to officers, and they will develop policy statements relating to those areas. It is important to understand how the policy will be adopted and who will take ownership, as we found in this project that it had previously been the concern of one key officer, who has since left their job. It will also be important to map stakeholders, in order to enable officers to understand who they should engage with in developing the policy further and enacting it. Stakeholders might involve members of the public, county council officers, and organisations such as the NCSC and the environment agency, who were identified in the research as being key to understanding which sensors are located where in the city.

Policy Area	Statement
Aims and Purpose of the System	Understanding *why* the system is being implemented
Data Collection	What data will be collected and how it will be collected
Data Management	What will happen to the data once it is collected? Who is responsible?
System Interaction: with people	How will systems interact with citizens in public spaces? Will they be aware of sensors?
Understanding benefits, challenges and risks of the system	Exploring how data might be used within and beyond the organisation. What physical risks might be present in the sensors.
Data sharing and collaboration	Who will data be shared with and how? Are there other sensors in the city that are owned by other organisations?
Data regulation	Will the policy be enforced? Will guidelines or regulations be involved?
Transparency	Exploring what citizens need to know and how they will be communicated with.

Table 1: Emerging areas of policy focus

From the findings of the workshop, we will then present the draft policy back to council officers and engage in developing processes for implementing and reflecting on the policy.

5.6 Implications for design research

This research project highlights the potential of using design methods in the development of policy at a local level. The use of design fiction, through the design of signage that was placed around the city sparked conversations about *possible* futures and implications between the participants and researchers. We found that using existing objects that were tangible, but with added functionality or features, enabled participants to grasp and then speculate upon how these might affect the public space in which they were situated.

While the use of speculative design and design fiction has been explored in the design of policy (Miller, 2020) it has not been widely written about. The development of policies can often be somewhat abstract, and we found this to be the case when exploring policy relating to IoT and emerging technologies. What the use of design fiction enabled us to do as researchers, was to explore possible futures ourselves, when designing the signage and thinking through the possible impacts and implications of the deployments. We walked in the city to choose specific objects, and then designed additional functionalities for each site. Through choosing additional functions that were based upon existing examples (which were

found in existing literature) and designing the signage, we found that the process enabled us to envision the potential implications of the policy, which hitherto had been somewhat abstract to us as design researchers.

The development of the workshop where we developed the policy with the participants also enabled us to visually think through and explore the implications of IoT policy that had been explored during the two walks. Through carrying out stakeholder mapping and then asking participants to work through a process of clarifying the policy statements using a set of cards, we were able to further develop the policy and encourage participants to explore different possibilities.

This work therefore contributes to the emerging corpus of case studies from within design research, where design methods are used in the development of policy *with* participants. It also highlights the potential for walking and other creative methods to contribute to the gathering of evidence and sense-making processes that are so important in the design of policies. This project was short in duration, but the city council are keen to work with us further in developing and implementing the policy, and forms part of a wider project which is exploring use of design methods in the context of local government (including systems mapping, design fictions and co-design).

5.Conclusions

This research is ongoing and is now in the final stages. We have identified key challenges and opportunities facing local governments as they increasingly deploy IoT and Edge technologies in public spaces. Furthermore, we have explored and opened future possibilities and conversations regarding these emerging technologies using novel methods, including city and online walks, and the use of design fiction. These methods enabled us to open spaces for conversations between different stakeholders, and use these as the basis for the participatory policy. During the upcoming workshop, we will not only present our policy recommendations, but develop these further with council officers. We have also developed an online tool, that will enable those involved in designing and deploying IoT in public spaces to explore and identify possible benefits and risks in this area, specifically relating to transparency, security and privacy.

This paper has shown the possibilities of using novel and engaging methods to begin conversations about emerging technologies in public spaces with a range of stakeholders. Furthermore, we have highlighted key themes that emerged from conversations between council officers and IoT experts, using design fictions. We plan to carry out further city walks with the public, as part of a wider public engagement programme, and to explore the roll out of the virtual walks to other towns and cities. We also plan to develop further case studies where the use of design fiction in process of policy making can be explored further and to develop empirical evidence that can inform a set of rigorous design principles that can be used by both design researchers and policy makers.

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