Taking IoT for a walk: Public Attitudes regarding sensors and IoT In public spaces

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Executive Summary

This report explores the public's perceptions and acceptance of Internet of Things (IoT) technologies within urban environments. The study was conducted through a series of public walks and engagements in Weymouth, Bridlington, Hounslow and Morley, aiming to capture a diverse range of opinions and attitudes towards the deployment and implications of IoT systems.

Key findings include varying degrees of acceptance and scepticism among participants. While some viewed IoT technologies as beneficial for improving accessibility and managing urban infrastructure, others expressed concerns about privacy, control, and the motivations behind IoT deployment. Where participants were more sceptical, transparency emerged as a crucial factor for building trust, with participants advocating for clear information on the function, purpose, and data management of IoT technologies.

Participants also demonstrated differing levels of understanding and comfort with specific IoT applications. Technologies perceived as directly beneficial, such as those aiding disabled individuals or managing traffic, were more favourably received than those with less obvious societal value, such as smart bins and lights. Trust in IoT systems was closely linked to the perceived intentions of deploying entities, with local authorities often being the de facto focal point of both trust and scepticism.

The report underscores the importance of transparent communication and accountability in the deployment of IoT technologies. It recommends that local authorities ensure the provision of accessible information to address privacy concerns and foster informed discussions about IoT systems.

Background

Public attitudes and trust regarding sensors and Internet of Things (IoT) in public spaces, such as footfall counters, air quality monitors and 'smart' street furniture, is an under researched area[1]. Understanding public understanding, hopes, concerns and perceptions may help address privacy and security issues, ensure initiatives are transparent and ethical, and foster trust in the local authority deploying the technology. A greater understanding of public perception and priorities can guide policymakers and developers in designing systems which align with local values: enhancing the benefits and minimizing the risks of harm associated with 'connected places' and 'smart city' initiatives.

[1] Public Perceptions Literature Review (publishing.service.gov.uk)

In 2021 Imagination Lancaster, Lancaster University's design-led research lab, received funding from PETRAS National Centre of Excellence for IoT Systems Security for a project titled Participatory Policies for Internet of Things (and Edge computing) Ethics with Lancaster City Council. The aim of the project was to develop a 'new, robust policy for ethical use of IoT data in Lancaster' and a fully implemented IoT Transparency Guidelines tool which can be used by organisations who are considering IoT deployments and wish to consider the transparency and security aspects and ethical data use. TrustLens, the resulting toolkit from this research can be found here.

One of the particularly innovative aspects of the project was the use of design fiction and walking workshops to gather insights. Design fiction uses fictional prototypes, or 'props from the future', to tell stories and create immersive scenarios which represent a possible future; it can be a highly effective way to explore how new technologies might change our lives, and to reflect on our relationship with technology today. In this work, the design fiction objects represented 'mundane futures', using near-future or existing technology that has nevertheless has not yet been deployed in Lancaster. We walked through the city with city council employees and explored the different ways in which both existing and made up sensors might impact the people and other inhabitants of these public spaces. One of the strengths of using design fiction, and particularly in developing policies, is that it can start conversations about an issue, and lets people think creatively beyond the constraints of reality.

Aims of Taking IoT for a Walk

Having delivered this in Lancaster we wanted to bring our research out to additional places across the UK. We also wanted to explore how these walks can be offered to the public to help local councils understand the thoughts and feelings of local people. In the summer of 2022, thanks to EPSRC Telling Tales of Engagement Funding, we were able to offer these walking workshops for four further local authorities. This report collates the findings of these four walks which took place over the spring and summer of 2023.

The four walks

We are very grateful to the Society for Innovation, Technology and Modernisation (SOCITM), the Local Government Association (LGA), and the Scottish Cities Alliance for allowing us to circulate the opportunity amongst their memberships, via their newsletters and at their events. Following multiple enquiries, the four who were the first to commit to a walk were Weymouth, Bridlington, Hounslow and Morley. The process, real and fictional deployments, and general outcomes of each location are listed below.

On each walk, participants (including both local council employees and members of the public) were led to a range of stops each of which was the location of either a real or fictional Internet of Things deployment. The real deployments were identified via a preliminary research walk and discussions with the local authority.

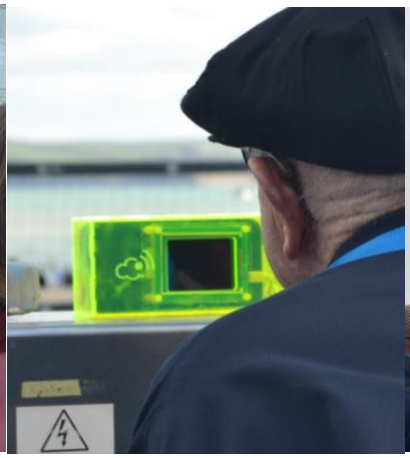
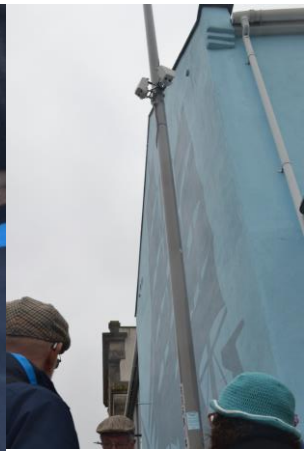
The fictional deployments were based on the local context and fully designed by our team with their purpose, operation and data management mapped out by us. However, the objects and signage (where relevant) provided only limited information allowing participants to speculate on their operation. We asked for initial thoughts at each stop before revealing more information about the deployment and asking for further feedback and views

Weymouth, Dorset (2 walks)

Location 1 was Weymouth, a Victorian seaside town located in Dorset, on the south coast. Weymouth are proud to be pro digital innovation, with a focus on rural connectivity, tourism and economic development.

Real IoT deployments in Weymouth identified during the research phase and preliminary walk included 'vivacity' road traffic sensors, pedestrian footfall sensors, CCTV, and air quality monitoring. The first three of these were directly incorporated into the walk, while the air quality monitoring inspired a semi-fictional implementation. We built a functional air quality monitor and placed this on the promenade, prompting a conversation about why air quality monitors are placed where they are. The air quality monitor included a small LCD screen displaying live data which provoked a conversation on accessibility and communication of data. The traffic and footfall sensors gave us an opportunity to explore public understanding and attitudes towards third party providers in IoT solutions.

Three fictional deployments were also included in the walk. The first fiction was wastewater digital surveillance, which is commonplace in wastewater treatment across the country. However, this fiction placed the sensors in the public toilets themselves, as opposed to further down the sewage system. This was accompanied by an intentionally ambiguous sign which stated "These toilets are being monitored by AI for your safety". This provoked conversations around privacy and why such data might be useful but is also difficult to collect and share. The second fiction was an advert for an app which provided locals with discounts when using a fictional scooter rental scheme if they shared location data. Finally, the third fiction was a sign alerting passers-by to drone usage via a yellow hazard sign and a flashing orange light. The drones in our fiction were imagined by us as finding lost children on the beach, which invited questions on whether the benefits of keeping vulnerable people safe outweighed the potential harms with regards to privacy.

Bridlington, East Riding (4 walks)

Our second location was another Victorian seaside town, but this time in the North East: Bridlington, in East Riding. There were some interesting similarities with Weymouth as East Riding applied IoT in similarly rural environments and with the aim of boosting tourism and economic development.

True IoT deployments which were incorporated into the walk were a smart bin, CCTV and footfall sensors; similarly to Weymouth we also incorporated our lab-made air quality monitor. The smart bin measured capacity but had been part of a previous pilot and was therefore surrounded by normal bins, this sparked a debate on how investments are decided upon and the human factors such as how these bins might change the jobs for refuse collectors. The footfall counter relied upon counting MAC addresses of passing devices, e.g. phones, which attempted to connect with it. This led to interesting conversations of to what extent this was an invasion of privacy and what this data could be used for. By comparing this technology with CCTV on the same street, which was accompanied by the usual yellow signage, we were able to discuss why some data collection is advertised and not others, and which they considered more or less acceptable. The air quality monitor triggered similar discussion points as Weymouth with the addition of how this data can be harmful as a recent table showed Bridlington, a tourist destination, to have the worst air quality in the UK; the table did not explain that this was due to a rare wind bringing Saharan sand at the time the data was collected.

Fictional deployments were sensors integrated into a disabled parking bay to monitor when it was available, and a sign on a normal lamp-post labelling it as a "smart lamp-post". The disabled parking bay led to conversations about whether this could be harmful given the more vulnerable nature of the users; but most were in agreement that this would be a very good use of technology to assist disabled people and reduce traffic burden. The smart lamp-post sign, as was the case in our later two walks, led to many different speculations: light sensors which turned it on when the environment was dark, motion sensors which turned the light on, other sensors such as noise, footfall and air quality embedded in the lamp housing, Wi-Fi hotspots, maintenance information,

and crowd/mood affecting light such as different colours to attempt to calm crowds at times when aggression was more likely or brighter lights to encourage crowds away from residential areas. Not only did this highlight the imagination of council officers and the general public, but also revealed a high level of acceptability, or expectancy, of IoT being used for social engineering.

Hounslow, London (1 walk)

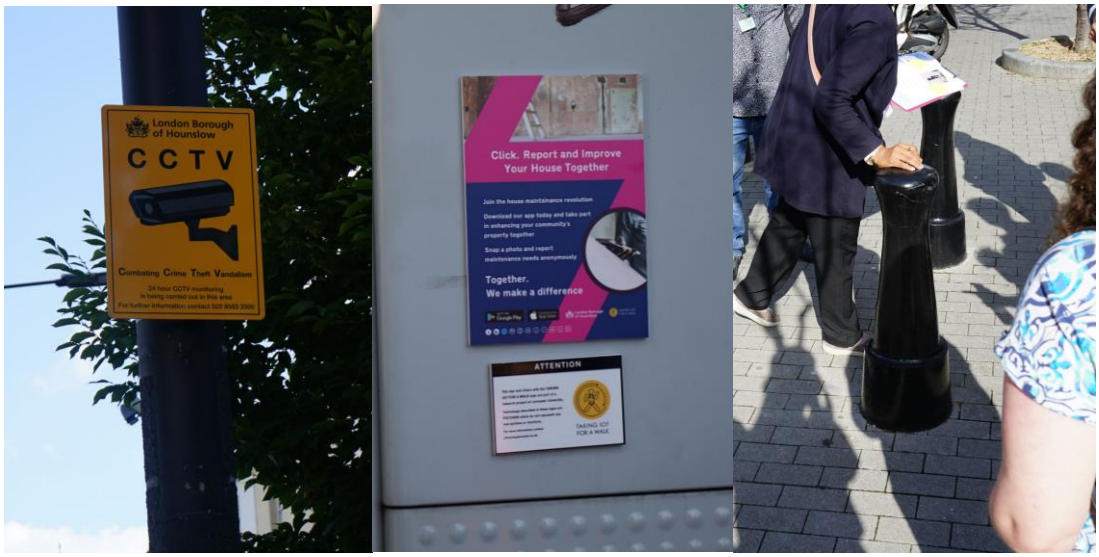
Our most urban destination was that of Hounslow, a borough of West London. Unlike the first two locations where councils were interested in IoT deployments, Hounslow were more curious about local residents' attitudes towards the council collecting data and what they expected to be communicated.

True IoT deployments included CCTV, which we found to be a helpful constant in comparing the way that data is already collected in in public spaces, and the lab built air quality monitor.

The first fiction encountered on this walk was the "this is a smart lamppost" sign, which was imagined to have similar functions to Bridlington. After this we encountered a 'smart bollard', inspired by pedestrian and cycle monitoring deployments elsewhere in the UK and described in Jacobs et al's 2020 research[2] which heavily informed the PETRAS funded project these walks were built on. There was no signage for the bollard, we merely pointed out a specific bollard and asked what they thought it did. The location, at an entry point to the high street, led to most people correctly suggesting it could be counting footfall. The next stop included adverts for an app and service which automated parking payment using Automatic Number Plate Recognition (ANPR). This stimulated interesting conversations about the acceptability and risks of automating actions based on sensor data, i.e. charging and fining. Finally, we encountered an advert for a new 'fault reporting and maintenance dashboard app' in a bus stop, which encouraged residents

[2] https://doi.org/10.1080/14606925.2020.1744259

to report issues with infrastructure or social housing. This fiction was the furthest we strayed from technology for a public place but it aimed to meet the aims of the council to explore public attitudes to data collection in both public and private spaces. This app would allow people to report faults or complaints quickly but would also show where these faults were and how quickly they were being repaired; participants agreed this would bring a desirable amount of transparency and accountability but that there were potential harms to revealing areas which were in more disrepair than others, especially if these were residential properties.



Morley, West Yorkshire (2 walks)

Our final location was Morley, a town in West Yorkshire and civic parish of the City of Leeds metropolitan borough. Leeds is often named as one of the more technically advanced cities in the UK, and this walk was part of Leeds Digital Festival. Morley had also recently received a grant via the government's towns fund in 2020, part of which was being invested in digital improvements and Leeds council were keen to hear what people's visions of the future were.

As with the previous two walks, we started by encountering a smart lamp-post, however, unlike the previous smart lamp-posts, this one was real, and connected to the internet. Or at least it was meant to be, to enable footfall counting, but the solar panels for the sensors had been vandalised or stolen – a talking point in itself. Shortly after this we encountered another familiar sensor: Vivacity traffic monitors being used at a busy junction.

Fictions included an ambiguously labelled "smart bin", which stimulated conversation of practical sensors such as capacity, weight or heat; and more social functions such as a rewards scheme for those who recycled correctly. For some this fed into the next fiction: a "smart screen" linked with a new local app which would display the most useful information for you when you stood in front of it. People imagined personalised adverts for their favourite shops and cafes, bus times for routes

they frequented and local news they might be most interested in, with concerns over bias and finances behind this system. The next fiction was an unlabelled drain for participants to speculate on. Our fiction design was a smart drain, monitoring flow and detecting blockages. Participants commented on the poor positioning of this sensor (up a hill) but that this would be extremely useful if relocated, given the propensity to flooding in other areas of town. Finally, we entered a park and utilised an existing birdbox for our final fiction. This was an audio based wildlife monitor that used AI to detect birdsong. Concerns were raised at a sensor 'listening' in a public space.


Some notable similarities and differences:

- All the walks were promoted through Eventbrite, social media and targeted marketing to resident groups.
- The timings of the walks meant that members of the public who attended them had certain things in common: they had the time to give, possibly because they were retired or did not need to work; and they were already engaged with the local council and local matters, suggesting they were less likely to be from marginalised communities.
- All of these walk routes walked through a high street; Hounslow was the only walk in which we included a residential area.
- Bridlington and Weymouth are both seaside towns for which tourists were key stakeholders when designing the walks.

A short summary of the methods:

For each walk, multiple meetings took place between the research team and the local authority to codesign a walking route and features. The following summarises the steps taken before each walk delivery, though these steps were not taken in a linear manner or in the same order for each place:

1) **Agreeing priorities:** The first meeting(s) (online) often focussed on understanding a local authority's motivation for requesting a walk. Some had specific deployments they wanted to test; others were more curious about their local citizens' perception of the council's handling of data in general. This first meeting was also used to understand the current IoT situation in this location and any local context that affected this.
2) **Initial fiction design:** The research team then brainstormed multiple fictions in response to these initial discussions, for the local authority to choose from for the final walk.
3) **Identifying true deployments and testing route:** The research team visited each place to walk to proposed route. This allowed us to test the feasibility of the route but also gain a deeper understanding of the context for both true and imagined technologies. On this walk, we found examples of true technologies which would be used on the walk, as well as identifying ideal locations for fictional technologies. This could have been ensuring that a technology felt right in that location, i.e. that the placement was believable; or, identifying existing street decoration/furniture of ambiguous purpose which we could appropriate for our fictions.
4) **Final fiction design:** Having agreed the selection and location of design fictions, the research team then developed the design of each fiction including mapping the functionality and data processing, and creating physical objects such as signage which would be used on the walk to create the immersive experience of the deployments.

Key Takeaways:

1. Public Imaginings and Acceptability:
   a) **Many participants envisioned using IoT technologies for social engineering and behavioural nudging,** such as controlling pedestrian flow or implementing reward schemes. While these uses were seen as beneficial by some, others felt uncomfortable with such control. When implementing any sensor/IoT based technology, it is therefore fair to assume that some citizens will believe it to be for this purpose and consider what concerns or confusion this could cause, especially should it not be the actual purpose.
   b) **Acceptability of technologies tended to correlate with perceived societal value**. Technologies aiding disabled people or managing traffic were favoured, while others like smart bins and lights were seen as less essential.

2. Cynicism and Trust:
   a) **Difficulty in identifying who is responsible for the technologies led to challenges in assessing their trustworthiness** and engaging in informed discussions about their deployment.

b) There was a prevalent cynicism about the motivations behind deploying IoT technologies, with **many suspecting the ultimate driver to be financial motives such as data monetization**.
c) **Trust in technology was closely linked to trust in the deploying entity**. Local authorities were the primary figures of trust or mistrust. Any lack of clear accountability risks exacerbating uncertainty towards the technology itself.
d) **Transparency was unanimously valued**. It was more important to some than others but it was a strong theme of each walk, with participants generally agreeing that information on technology function, purpose and safeguards should be easily available to anyone that wants it.
e) **Trust in technology was distributed and nuanced, heavily influenced by the perceived intentions and accountability of those deploying it**; and the participant's pre-existing opinion towards the deployer.

3. Security, Privacy attitudes, understanding and uncertainty:
   a) **The majority of participants viewed existing surveillance technologies positively** and an effective way to reduce anti-social or criminal behaviour. However, our participants were not fully representative of their diverse communities and it is important to emphasise that others in the community may not feel the same.
   b) **Many participants highlighted security risks and concerns** showing, if not always using technical language, confidence and awareness when it came to evaluating cybersecurity vulnerabilities.
   c) **Participants often struggled with understanding the implications of IoT technologies**, leading to ambivalence about privacy, proportionality, and desirability.
   d) **Responses to technology use varied, even for individuals.** The perceived potential for new technologies to invade someone's privacy, for example drones or MAC addresses (the unique number broadcast by your internet enabled device when trying to connect to available networks) was varied but often contradicted a participant's opinion towards existing technology such as CCTV. For example:
      i. While many did not care about MAC address detection, for some, a lack of full understanding of how that technology worked led to concern for the data to be misappropriated, though participants struggled to articulate why they were concerned. It was also harder for participants to imagine uses for this data, which in practice is more useful for supporting local authorities in evaluating change than in delivering a direct action such as providing an individual with medical support, arresting a criminal or changing a traffic light.
      ii. Drones however, which were utilising facial recognition and cameras, were easier for participants to discuss and articulate concerns over given their similarity to existing

CCTV systems. The purposes of these technologies were also easier for participants to imagine and understand. Participants were then much more capable of articulating where their 'red lines' would be for these technologies and to explain how the ends could justify these means.

4. Perception and Empathy:
   a) **Surveillance was typically discussed in abstract terms, focusing on general populations rather than personal impact**, which reduced empathy for potential harms. This is particularly important to consider when integrating any public consultation on harms; it is critical to question how a local authority can ensure that marginalised communities and individuals have been considered in any impact assessment.

5. Communication and Understanding:
   a) **A slight majority of participants were ambivalent towards signage and information,** stating that they did not care enough or have the time or energy to invest in understanding how their data was being collected, managed or used.
   b) **However, a minority were concerned and expressed a need for better information to understand how technologies function and their implications.**
   c) **Signage and terminology were often inadequate, with participants suggesting that QR codes or links to detailed information would be more effective**. Though others did question the accessibility of these communication methods also.

Recommendations for Local Authorities

1. Enhance Transparency and Accountability:
   a. Clearly communicate who is responsible for deploying, managing, and overseeing IoT technologies. Transparency about data usage, ownership, and privacy protections is crucial to building trust.
   b. Establish clear accountability mechanisms and ensure the public are able to easily find out who to contact with concerns or questions.
   c. Provide detailed, accessible information through multiple channels, including online resources, community meetings, and clear signage.
   d. Use consistent language and take time to agree internally what ambiguous words such as 'smart' mean; and whether they should be used at all.

2. Address Privacy and Ethical Concerns:
   a. Implement strong privacy protections and ensure data collected by IoT devices is used transparently and ethically.
   b. Offer opt-out options where feasible and clearly explain how data will be used and protected.

3. Focus on Societal Benefits:
    a. Prioritize deploying IoT technologies that offer clear, tangible benefits to the community, such as aiding disabled individuals or improving traffic management.
    b. Avoid deploying technologies perceived as non-essential or controversial without thorough public consultation and justification.

4. Improve Communication and Signage:
    a. Use clear, consistent language to explain IoT technologies and their functions. Avoid jargon and ensure definitions are easy to understand.
    b. Enhance signage with QR codes or web links to detailed information, catering to both those who seek detailed explanations and those who prefer minimal information.

Questions Local Authorities Can Ask Their Citizens:

1. Be both open and specific when asking about perception and acceptability:
    a. How could technology be most useful or beneficial for our community?
    b. Are there any technologies you feel uncomfortable with? Why?
    c. How do you feel about the introduction of *'specific technology x'* (e.g., sensors which count footfall) in *'place x'* for *'purpose' (e.g. to evaluate what affects the number of people using this area and how local services)*?
    d. What are your primary concerns regarding the privacy and security of data collected by 'specific technology x' in 'place x' for 'purpose x'?

2. Communication and Engagement:
    a. How would you prefer to receive information about new technologies being implemented in our city (e.g., websites, community meetings, signage)?
    b. What kind of information would you like to see on signs related to new technology (e.g., data being collected, purpose of the device)?
    c. Do you find QR codes or web links to detailed information useful when you see them on public signage?

3. Accountability and Control:
    a. Who do you think should be responsible for managing and overseeing the deployment of new technologies in our city?

Questions for Local Authorities to Ask Themselves and Delivery Partners:

1. Assumptions and Objectives:
    a. What assumptions have we made about the benefits and risks of deploying this IoT technology?
    b. What could the public think this technology is for?
    c. Are we prioritizing technologies that offer clear, tangible benefits to the community?
2. Privacy and Security:
    a. What measures are in place to protect the privacy and security of the data collected by these devices? And, how can these easily be communicated to anyone with a concern or question?
    b. How will we ensure transparency about data collection, usage, and sharing with the public?
3. Communication and Transparency:
    a. How are we currently communicating with the public about IoT deployments? Is this approach effective?
    b. Are we using clear, accessible language and providing sufficient details about the technology and its implications?
    c. How can we improve our signage and informational materials to better inform and engage the public?
4. Accountability and Governance:
    a. Who is responsible for the management and oversight of each IoT technology we deploy? Is it easy to find this information?
    b. How can we establish clear accountability mechanisms for the data and technologies used?
    c. What steps are we taking to ensure that responsibility is transparent and easily understood by the public?
5. Ethical Considerations and Public Engagement:
    a. Have we conducted thorough ethical reviews of the IoT technologies we are considering?
    b. How are we involving the community in decision-making processes about these technologies?
    c. Who has been involved in consultation and engagement to date? How have we used varied consultation methods to ensure this our research is representative?
    d. Are there opportunities for public feedback and consultation, and how are we incorporating this feedback into our plans?
6. Evaluation and Adjustment:
    a. How will we evaluate the impact and effectiveness of deployed IoT technologies?
    b. What criteria will we use to determine whether a technology is successful or needs adjustment? Do these criteria reflect the concerns, hopes and language of citizens?

c. How will we address any negative feedback or unintended consequences that arise from the deployment of these technologies?

Conclusion:

The study reveals a complex landscape of public attitudes towards IoT technologies in urban spaces. While there is potential for these technologies to enhance urban living, significant efforts must be made to address public concerns about privacy, control, and transparency. Building trust through clear, transparent communication and ensuring that the societal benefits of IoT deployments are evident will be essential for gaining public acceptance. Local authorities should prioritize inclusive consultation processes and provide easily accessible information to foster a well-informed, engaged community.

Feedback:

Please do let us know if you have found this report useful when making your own policy design, or have observed things which confirm or contradict our findings we would love to hear from you.

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