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# Sustainability means inclusivity: engaging citizens in early stage smart city development

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***Abstract*—The challenge of how cities can be designed and developed in an inclusive and sustainable direction is monumental. Smart city technologies currently offer the most promising solution for long-term sustainability. However, smart city projects have been criticised for ignoring diverse needs of the local population and increasing social divides A sustainable urban environment depends as much on creating an inclusive space that is safe, accessible and comfortable for a diverse group of citizens as it does on deploying "smart" technologies for energy efficiency or environmental protection. This is because citizens will be more likely to adopt technologies promoting sustainability if they are well-aligned with their lived needs and experiences. In this paper, we present the rationale behind an ongoing interdisciplinary research project that aims to address exactly the problem outlined above by using a participatory design approach. Focusing on a smart city test site in Sweden where sensors are currently being deployed to collect data on noise, particles, vehicle numbers and types (amongst other), the goal is to bring local residents and government representatives into dialogue with technical developers by adopting a "meet-in-the-middle" approach. This paper comprises a brief presentation of early findings and a reflection on this approach.**

***Keywords—smart city, IoT, participatory design, inclusivity, interdisciplinarity, Living Lab.***

## I. INTRODUCTION

The challenge of how cities can be designed and developed in an inclusive and sustainable direction is monumental. Smart city technologies currently offer the most promising solution for long-term sustainability. This solution involves integration of digital technologies into the urban environment to capture data about daily life. This approach can be deployed in brand-new smart cities or in the "smartification" of existing cities.

In the smart cities model, the Internet of Things (IoT) is a key technical enabler as it allows sensors, software, and communication functionalities to cooperate with other connected devices. This makes it possible for sensors to provide data which will be used to act upon their environment, e.g. fitting trashcans with weight sensors allows collection to take place only when needed, reducing garbage truck trips which reduces traffic, pollution and personnel costs. Participatory sensing (PS) transforms the IoT into an Internet of People by allowing citizens to network and share sensor data from their personal smartphones [1]. PS has the potential to involve and engage local communities in collecting and sharing data about their environment with the goal of addressing relevant challenges (e.g. traffic emissions) whilst at the same time empowering community members to make informed decisions about their daily routines (e.g. route or mode of transport) [2]. To date, however, PSs have mostly failed due to limited contribution by users and little trust from involved stakeholders. Participation has been limited to specific user groups and, although techniques to ensure participation are well understood at the technical level, they do not match well in the real world [3].

This example of PS exemplifies one of the major stumbling blocks for the success of smart cities. Smart city projects are often premised on a technology-centric, top-down vision of the urban space. This approach uncritically reproduces assumptions about use(r)s, and gives more weight to technical innovation than lived realities of end users.

Urban development scholars have long highlighted how assumptions about use(r)s become embedded in the cityscape as designers' assumptions shape buildings and infrastructure [4]. For example, research has shown how poorly-lit streets or limited-use thoroughfares may cause women to fear being attacked in these spaces and thus limit their movement through urban space particularly after dark [5]. Smart cities risk falling into the same trap if designers and developers do not reflect on the assumptions about use(r)s built into the technologies [6]. This is an increasingly urgent problem due to the growing global popularity of smart city solutions, some of which have already had highly problematic consequences [7, 8]. In particular, smart city projects have been criticised for ignoring diverse needs of the local population and increasing social divides [9].

A sustainable urban environment depends as much on creating an inclusive space that is safe, accessible and comfortable for a diverse group of citizens as it does on deploying "smart" technologies for energy efficiency or environmental protection. This is because citizens will be more likely to adopt technologies promoting sustainability if they are well-aligned with their lived needs and experiences.

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In this paper, we present the rationale behind an ongoing interdisciplinary research project that aims to address exactly the problem outlined above by using a participatory design approach. Focusing on a smart city test site in Sweden where sensors are currently being deployed to collect data on noise, particles, vehicle numbers and types (amongst other), the goal is to bring local residents and government representatives into dialogue with technical developers by adopting a "meet-in-the-middle" approach [10], We follow this with a brief presentation of some early findings from the fieldwork and a reflection on the challenges of this approach.

## II. Materials and Methods

An IoT testbed is being deployed along the full length of Kungsgatan, Norrköping, Sweden, 2019 - 2021. The road is slightly over 1km in length, with an emergency services station located at one end and the police station at the other. It comprises a wide range of buildings, including university premises, housing, restaurants/cafes, stores. It is in an area where construction is taking place, so in addition to a busy flow of residents, students and businesses, there are also large vehicles delivering materials to building sites. Part of the road runs over a bridge with footpath. Close by there are elder care facilities, nurseries, schools, pubs and housing located so the area experiences a wide variety of users.

In this project we use two complementary methods to explore the testbed and engage with its potential users. First, we engage in an in-depth, STS-inspired ethnographic process that asks: what assumptions do technical developers and other "top down" stakeholders have about what constitutes "useful" data to collect from a smart city test site? Second, we conduct a Living Lab (LL) participatory design process that works closely with a range of citizens to explore how their needs can be best served by the test site. By placing the findings from these two processes in dialogue with one another, we will raise awareness of local needs, elucidate the fit between design assumptions and real use, and empower local citizens to initiate data collection through the test site that addresses their own concerns.

This paper focuses on the Living Lab aspect of the project.

## III. Current Status

As a first step towards setting up a Living Lab, we organized a pilot workshop in September 2019 to establish initial contact with local residents and businesses. Two researchers delivered printed invitations in person by visiting the shops along Kungsgatan. The invitations were also sent via email to the municipality, the elderly care coordinator, the local day-cares, and other educational organisations in Norrköping. A total of 11 people attended the workshop. Using pictures of Kungsgatan taken at different times and locations, we asked the participants to work in two groups to identify the positive and the negative things about Kungsgatan in its current state. We started with the positive round, did a feedback round and after a break we moved on to the negative one. The pictures worked well, with people annotating and adding comments using pens and sticky notes (Fig.1). Some of the more senior participants shared their reflections on how the street has changed —for example after the university moved in in the early 2000s— and their frustration with the poor traffic flow. Some even talked about how they actively avoid Kungsgatan now. In addition to positive aspects of the street, poor lighting, building work-related pavement problems, and low air-quality in some spots were among the issues that the participants expressed, suggesting preliminary cues on the type of sensors to use and places to deploy them.

Fig 1: September workshop: participants working on annotating the pictures

Following our pilot study, we planned a second workshop to take place in Spring 2020 that would launch the Living Lab. The original purpose of this citizen workshop was twofold: To shift gears from exploring current Kungsgatan to envisioning future Kungsgatan (Fig. 2), and to recruit participants for the Living Lab process in Fall 2020. For the workshop, we had initially planned a physical gathering, offering different co-design activities where diverse stakeholders would collaborate closely with each other to explore alternative futures. However, we had to postpone this workshop because of COVID-19 restrictions. This situation encouraged us to attain our goals through alternative, COVID 19-restriction-compliant means. In this direction, we considered cultural probes as a suitable qualitative method as it is a future-oriented approach. In a nutshell, a cultural probe is a package of items purposefully arranged around a few tasks to engage people with a topic or theme, with the goal of eliciting their needs and wishes [11]. It is a package that researchers deliver to participants, provide some instructions, and ask them to return it once they have gone through the items. An advantageous aspect of cultural probes is that they offer approachable and inclusive activities: on the one hand, they allow researchers to include physical items that participants can engage with; on the other, they contain non-digital, familiar objects that some participants might find more accessible.

We designed a cultural probe that comprised two slightly different packages, with an emphasis on playful creativity and co-located collaboration that is similar in spirit to the expected work in Living Lab. In this sense, the probes themselves also became an invitation and a warm-up for the kick-off workshop. The common item in both packages was a packet of coffee as the cultural probe was based on the idea of using coffee fortune-telling —a traditional way of speculating on possible futures through free interpretation of non-figurative images in the bottom of the cup— to offer participants a collaborative medium to explore alternative futures in a playful and informal way [12]. In terms of tasks, one package contained an empty interview card with a future Norrköping resident to be filled in through an imaginary conversation while the other a partial map of Kungsgatan to complete with drawings reflecting the imagined future urban space (Fig 3: packages with included materials). The packages —providing the necessary instructions in both Swedish and English— asked participants to make coffee, enjoy it with their loved ones, and use the visual material in the cup as a source of inspiration to do the probe tasks. We delivered these packages both via post and in person visits along Kungsgatan to 50 people during June 2020. We are currently in the phase of collecting the packages —so far 8 people returned the

packages with completed tasks— and inviting participants to the citizen workshop that is planned to take place in September 2020. Our plan is to use the task materials returned by the participants as raw material in the workshop to initiate discussions and conduct co-design activities around their visions on Kungsgatan.

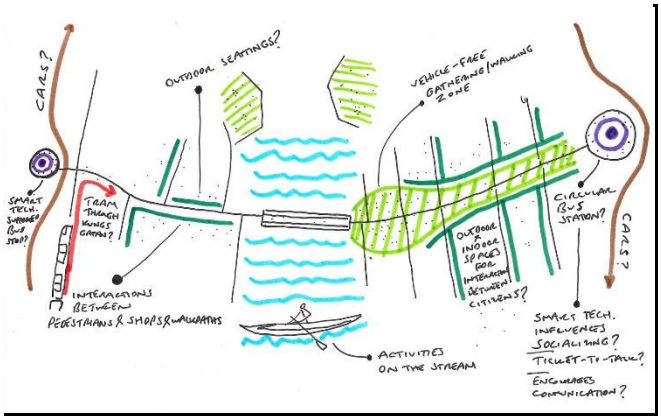


Fig 2: A sketch made by one of the researchers depicting an alternative future of Kungsgatan, inspired by the conversations with citizens as well as the project team in the exploratory phase.

Fig 3: Cultural probes in the making: partial Kungsgatan maps as task materials, envelopes, and instructional documents bearing the project logo.

In parallel with these efforts to attract participants, the sensor boxes that will be located on Kungsgatan are being developed. These sensor boxes will enable the desired IoT concepts, which are expected to emerge during the citizen workshop as well as the Living Lab through close collaboration between diverse stakeholders, and based on data collection strategies driven by citizens' needs and concerns. Within the project team different kinds of sensors have been discussed, as well as the location of the boxes. Here practical aspects have been highlighted, such as power sources for the boxes. Due to limited access to power sources on this road, the boxes must be placed where access can be negotiated, rather than where participants would ideally like the sensing to take place. Supplies for the construction of the full set of sensor boxes have also been delayed by COVID-19.

## IV. Interim Reflections

Taking careful account of the diversity of human needs has the benefit not only of making urban spaces comfortable and safe for more people, but also of improving chances of new technologies being adopted by the whole community. This is easier said than done, however.

We chose the overall approach for our project based on a number of principled arguments drawing on established knowledge from the fields of participatory design and sociotechnical interventions:

- Public spaces are contested territories where the interests of many constituencies intersect. Smart city technologies represent interventions in such public spaces. Developers of smart city technologies benefit from learning about the perspectives of citizens and other stakeholder groups, just as citizens and other stakeholder groups benefit from learning about the properties and potentials of smart city technologies [13].
- In general, long-term adoption and appropriation of new technology in a sociotechnical setting is more likely if the stakeholders of the setting are actively involved in the development of the new technology [14].
- The intervention of developing new technology for a sociotechnical setting is more like an ongoing process of transformation than a limited project with requirement elicitation, implementation and deployment [15].

At the current early stage of our work, we see no reason as yet to question the principled arguments for the approach we have chosen. We still expect to reach a fair level of understanding on how smart city technologies can be made useful and meaningful for diverse groups of stakeholders around Kungsgatan, Norrköping. But we already have a number of tentative observations that may be of value for other researchers, designers and developers facing similar challenges and opportunities.

Recruiting participants for the Living Lab is a demanding, costly and highly unpredictable process. We find that it is best viewed as a process of mutual satisficing. Project owners aim to put together a task force representing the diverse stakeholders involved in the sociotechnical setting as well as possible within the limits of project time and resources. It is important that the recruitment methods convey a good sense of the nature of the work to be done in the Living Lab, in order to set realistic expectations. Participants, on the other hand, aim to be able to make a difference and make their efforts count. Their time for voluntary engagement is limited, of course, and they need to use it wisely.

A fundamental tenet of participatory design is co-determination: the participants have real agency in return for their investment of time and engagement. This implies that the project owners – in our case, the researchers – need to hand over (some of) the authority and instead focus on the opportunities to learn about the setting and the stakeholder perspectives.

Doing research through design implies an open and explorative process, where the shape and form of the final outcomes are determined during the research itself (as opposed to being specified at the outset). This is a challenge for the established research infrastructure, in terms of project management models as well as funding schemes.

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