Urban participatory sensing means citizens using lightweight and accessible sensor technologies to gather and share data in order to collectively monitor the environment. Urban sensing technologies range from specific sensors or applications that augment mobile phones to increase their functionality, to ‘smart’ and connected devices. Although there have been a vast number of citizen sensing initiatives (e.g. instigated by researchers and some technology entrepreneurs) there are no large-scale examples of sustainable citizen-centred initiatives.

A citizen-centred sensing programme can bring about benefits to society. For example, by collecting and sharing data about environmental factors, citizens can become aware of how their lifestyles affect the ecosystem, identify local issues such as noise or air pollution, and learn more about and act on their environment.

However, there are challenges associated with such an approach. Previous experiences have shown that citizen engagement with participatory sensing initiatives can be hindered if people lack the skills required to configure, use and maintain sensing technologies, and struggle to make sense of the data collected. Moreover, there’s a need to consider how to reward participation, incentivise community connectedness, and foster a shared sense of purpose.

Method
Following a period of research and planning, we have developed “The Bristol Approach” to urban participatory sensing interventions, with particular focus on the drivers required to foster inclusive participation, scalability and sustainability.

The primary aim of using this method is to foster citizen innovation for the common good - and the proposed approach focuses on the development and evolution of a ‘city commons’ that supports the deployment of new or adapted technologies into everyday environments.

A co-created city commons can benefit society as a whole by supporting the development of new solutions to local issues, enhancing existing infrastructure, and increasing access to a data economy, skills and professional and entrepreneurial opportunities.
A GENERATIVE CITY COMMONS APPROACH TO URBAN PARTICIPATORY SENSING

To be purposeful, sustainable and scalable a participatory sensing programme needs to be:

• An issue driven initiative...
  Data sensing initiatives need to address issues that are relevant to the citizens. Air quality projects have been the most common initiatives to date. However, the data collected by citizens has proved useful, been shared and even integrated into official data sets only in cases where pollution posed a real life threat to the inhabitants (e.g. Fukushima after the nuclear disaster at the Daiichi power plants) and the technology provided accurate measures.

• that gathers an emergent community...
  Communities tend to gather around, and engage with, issues of concern. Examples include individuals supporting Kickstarter projects and Open Source communities gathered around the development of a piece of hardware. These emergent communities can be supported by pre-existing communities that are already concerned or involved with the issue, and therefore provide distribution and communication channels, as well as members and support.

• who are supported to develop and share the necessary skills...
  Citizen-sensing projects require specific technical skills. The most successful initiatives have been those where citizens acquired and shared the skills needed to contribute, with both project and the individual benefiting from their participation. People’s engagement with a project is strengthened when they have the ability to operate and interpret the data they’ve helped to create.

• and data economy incentives...
  Citizen-sensing projects are an opportunity to generate awareness of the value of data, yet ways to reward and incentivise citizens to contribute data over a period of time remain a challenge. In a data-driven economy, the data provider – here the citizen producing the data – should be entitled to a share of the aggregated value that results from the data collected. Such an incentive can help to sustain the citizen’s contribution to the data economy.

• to deploy and sustain an ad hoc network of devices...
  Sensors should not be understood as devices, but as sensing capacities added to places, people, situations and things. Sustainable sensing networks are ad-hoc and purpose-built. They do not need to be deployed as previously existing networks that have been developed for other purposes (e.g. lighting or postal).
Citizen-generated data should be a common good at the service of its citizens. Initiatives where data is presented back to citizens – in public community displays, artistic interventions or in bespoke sensor enclosures, for example – have reported the highest levels of citizen engagement. Initiatives that made their data flux available and interoperable (for others to make use of) have shown the highest levels of replication.

Which adds a layer of value to the territory...
By incorporating and processing existing data from multiple sources, initiatives can attain a new level of efficiency. Peer to peer production modes like CarPooling and Wikipedia have proven to provide infrastructural value to places, in the case of higher transportation frequency and access to universal knowledge. Information-intensive competitors can then enter the market and utilise the open data to substantially increase the general performance of the ecosystem.

And provides opportunities to its inhabitants...
This new approach aims to directly benefit those who contribute data and, ultimately, all citizens. While contributors will be rewarded for the data they contribute and the skills they develop, society as a whole will benefit from new technical solutions to local issues, enhanced existing infrastructure, and increased access to a data economy, skills, and professional and entrepreneurial opportunities.

THE FRAMEWORK
This new approach informs an actionable generative framework. The model is issue- and community-driven, and comprises three phases of value creation and three sets of actions, which are required to move from one phase to the next one. The three phases are: framing, deployment and outcome. The three sets of actions are identification, design and orchestration.

WHAT NEXT?
APPLICATION OF THE FRAMEWORK
IDENTIFICATION
An initial phase of identification will take place working with community networks, the city council, and voluntary sector organisations to map out local issues and identify and connect emergent and geographical communities that are involved with or affected by the issues. Selecting and framing the issue will be crucial to the success of the intervention. Issues that attract an emergent community are likely to have the energy necessary to spark and sustain engagement. Local SMEs working on the identified issues should also be mapped and connected. This identification phase aims to create a group of stakeholders who can agree on the goals and timeframe of the intervention and discuss what results are expected and how the outcomes will be assessed.

FRAMING
The output of the initial set of actions (Identification) will lead to a framing that clearly states the issue(s) to be addressed in the programme, the communities and stakeholders that choose to be engaged with it, and the assets that are already available and can be leveraged, as well as those that need to be developed. To transition to the deployment phase, stakeholders need to engage in a set of actions that we have labelled as “design” and which aim to define how the issue will be effectively tackled.
**DESIGN**

During the design phase the team overseeing the project (the project orchestrators) will collaborate with stakeholders, using participatory approaches, to identify the capacities that are required for the intervention to meet its goals. They will also identify any missing networks. Questions about how to generate and visualise the data, the incentives for contributors, and how contributors are rewarded will be addressed during this phase.

Tools for data collection and visualisation will be utilised and adapted or purposefully designed during this phase. The stakeholders will identify the skills that are necessary for communities to develop, maintain or use the technologies and then design the programmes that are necessary to enable such learning. SMEs, local artists and researchers may work with the communities of interest to co-create the systems and services that will enable data collection and visualisation (from sensor cases to displays and apps). Additionally, the stakeholders will negotiate and agree the ownership of the data generated during the intervention and the governance of the resulting commons.

**DEPLOYMENT**

The output of the set of actions carried out during “design” leads to a deployment stage where the community has developed the necessary skills to drive the intervention and produce the new layer of commons, new networks have been created, and the data economy incentives can be rolled out. The set of actions required to move from deployment to outcome is orchestration intensive and it aims to leverage broad engagement to maximise participation and support scalability.
**ORCHESTRATION**
The orchestration phase draws attention to the intervention and will engage communities beyond the immediate stakeholders. We aim to collaborate with citizens to design and deploy community displays, encourage third parties to use the collected data to create their own visualisations, and collaborate with journalists who can tell stories based on the data feeds contributed by citizens.

**OUTCOME**
By the end of the intervention contributors will be rewarded for the data they contribute and the skills they developed, and society as a whole is likely to benefit from: new solutions to local issues, new business, the enhancement of available infrastructure, and access to a data economy, skills and professional opportunities. The resulting city commons will grow as more interventions are completed using the generative framework. Finally, each iterative cycle will contribute know-how regarding how to implement the framework and enable inclusive and sustainable citizen participation.

**CONCLUSION**
The iterative application of this framework in subsequent community technology programmes will lead to the growth of the ‘city commons’, and enable us to understand better how to encourage innovative and active citizenship. We believe that “The Bristol Approach” will empower citizens to collectively address local issues and achieve the neighbourhoods that they want to live in.

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