RETHINKING SMART CITIES FROM THE GROUND UP

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RETHINKING SMART CITIES FROM THE GROUND UP

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Foreword

CY Yeung, Director, Corporate Responsibility, Intel China; Vice Chair of the Board, Cinnovate Center

At Intel China, corporate social responsibility is not only about what we do, but what we can make possible.

Many of the prevailing social and environmental challenges today are the outcomes of rapid economic growth, well beyond the grasp of individual organisations. For this reason it is imperative that we bring together the best minds around the world to learn, explore and co-create solutions that tap into the potential in grassroots innovation and building on this, to bring the entrepreneurial fervour, intellectual rigor and discipline of the business world into a societal context in the name of social innovation.

Urbanisation has been viewed as a panacea for development by many emerging economies. However, if the ultimate goal of cities is to ensure sustainable growth and make citizens happy and fulfilled, they have to adopt and develop tools that tap into the skills and knowledge of citizens. To do this we need to redefine smart cities as people-centred smart cities, or 'smart cities 2.0.'

We believe in the power of corporate social innovation whereby leading organisations, with their global footprint and touch points, leverage their core capabilities. If the purpose of technology is to improve people's lives, we have to break down the boundaries between technology innovation and social innovation.

With this vision in mind, in 2012 Intel China incubated an independent not-for-profit organisation, Cinnovate, with the support of the Chinese government to champion social innovation by catalysing cross-sector collaboration among government, civil society, industry and the academic community.

We are delighted to work with Nesta and the UNDP China on *Rethinking smart cities from the ground up* and hope it will stimulate thinking and action from cities around the world in how to use the combination of technology and people to make cities smarter.

Foreword

Geoff Mulgan, Chief Executive, Nesta

Cities tend to attract smart people and smart institutions. With each generation of technological change they've been given new ways to make the most of their brain power – from telephones and broadband to link people up, to smartphones that can guide people around city streets, to online platforms that can bring them together to solve complex problems.

Over the last two decades the label 'smart city' has been applied to a family of technologies that can speed up the flow of things around the city and reduce the physical frustrations of urban life – free flowing traffic instead of jams; smart flows of energy and less waste; public services better targeted where they are most needed.

Many of these innovations are obviously useful. At their best they oil the wheels of city life, and looking ahead there can be little doubt that every aspect of city life will be re–shaped by far greater flows of data and communications.

But some of the smart city ideas took a wrong turn, too often emphasising expensive hardware rather than cheaper solutions using the internet; too often showcasing technologically interesting ideas rather than responding to citizen's real needs (how many people really want their refrigerator to tell them when they're running low on essential foods?); and too often making over–inflated promises that couldn't be supported by hard evidence.

That's why the smart city movement is now turning in a rather different direction. It's combining the best of new generations of technology that can use data, to co–ordinate, analyse and target, while also involving citizens much more closely in shaping how cities can work. As in many other fields, technological innovation is being combined with social innovation and as a result achieving a lot more.

Our work at Nesta touches on many aspects of the smart city – we've developed new ways to map patterns of economic change and the growth of industries like games and software; we've invested in many companies with clever tech solutions; we've experimented with new ways of tapping citizen brainpower in fields like healthcare; and we've helped city governments plan and innovate more effectively.

Intel has been a pioneer in many of these fields, and China is now the site of more smart city experiments than anywhere else in the world. So we're delighted to be able to partner with Intel China in producing this report which we hope will both inspire and guide cities in China and elsewhere to harvest the best ideas of all of their citizens to make cities more liveable.

Acknowledgements

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PART 1

THE CASE FOR PEOPLE-CENTRED SMART CITIES

As cities bring people together to live, work and play, they amplify their ability to create wealth and ideas. But scale and density also bring acute challenges: how to move around people and things; how to provide energy; how to keep people safe. For several decades the ideas brought together under the label 'smart cities' have offered answers to these challenges. The combination of sensors, data and advanced computing has promised to speed up information flows, reduce waste and sharply improve how efficiently resources can be managed.

Cities and national governments around the world are investing in the potential of smart cities at an ever increasing rate: in China and India alone almost 300 smart city pilots are currently planned, and Arup predicts a global market for smart city technologies and services worth $408 billion by 2020.[1]

There can be little doubt that successive waves of digital technology will continue to transform how cities are run. But the advocates of smart cities have often faced criticism: for being too concerned with hardware rather than with people; too focused on finding uses for new technologies rather than finding technologies that can solve pressing problems; and for emphasising marketing and promotion at the expense of hard evidence and testing solutions out in the real world.[2]

As a result, many smart city ideas have failed to deliver on their promise, combining high costs and low returns. As we explore in this paper, many city governments are now trying to put this right, to reap the full potential of new digital technologies while not repeating the mistakes of the past. They are looking for answers that involve the public in both shaping technologies and implementing them; solutions that are cheaper and more modular; and they are seeking out evidence instead of hype. Here is a snapshot of some of the many examples discussed in this report:

Mapping urban flooding and air pollution

Building on the successful examples of Ushahidi and OpenStreetMap, people are using digital technology to measure and map their cities. Individuals and community groups can use low–cost environmental sensing kits like the Smart Citizen Kit to measure air pollution and upload the data to create crowdsourced maps. This data could be used to supplement professional sensing networks in the near future.

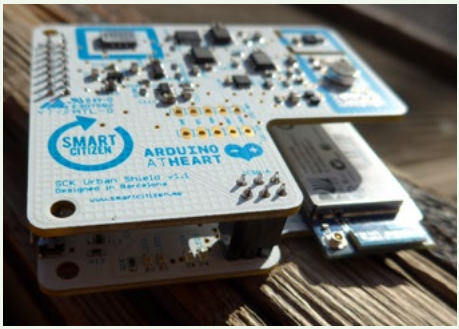
In Jakarta, a city which experiences severe annual flooding during the rainy season, researchers have developed PetaJakarta, a real–time map of flooding in the city created by crowdsourcing flood reports from Twitter.

Connecting urban communities to improve sustainability

In Seoul, South Korea, the city government is helping residents make better use of the things they own with the Sharing City Seoul initiative. It has supported a range of projects from local car–sharing company SoCar to websites like Billiji that help people share things with their neighbours. The goal of these services is to provide people with an alternative to owning things they rarely use.

Tapping into the knowledge of citizens

In Beijing residents can use the 'I love Beijing' app to report issues such as broken streetlights and potholes to the city government. The app extends the features offered by succesful issue reporting apps like FixMyStreet in the UK, by also including a map of the city's informal food markets. Residents can add a range



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Smart Citizen Kit

The Smart Citizen Kit is a low–cost environmental sensing kit.

of information to the map including opening times, new markets and what type of goods they sell.

Opening up decision making

In Reykjavik, Iceland, citizens can use the Better Reykjavik website to propose, debate and vote on ideas for improving the city. Each month the city council debates the most popular ideas from the website and the city government has so far spent €1.9 million on developing more than 200 projects proposed by citizens.

In Paris, 'Madame Mayor, I have an idea' is a crowdsourcing and participatory budgeting process that lets citizens propose and vote on ideas for projects in Paris. The process will allocate 500m Euros between 2014 and 2020.

Bringing people into the planning process

In Bangalore, local NGO the MOD Institute enabled residents to create a community vision for the future of the Shanthingar neighbourhood of the city by encouraging online debate. The project identified abandoned urban spaces as a major issue of concern for residents and created software which residents will be able to use to map these spaces via smartphone and SMS.

Traffic management

In Jakarta, residents can use Twitter to organise shared car journeys to work. The Nebengers Twitter account has 83,000 followers and re–Tweets 1,000 requests for ride shares each day. This could contribute to easing traffic woes in the city if the platform continues to grow.

Rethinking smart cities from the ground up

The overhyped claims of the smart city have been mirrored in over pessimistic critiques. This report argues that we need to

move beyond both – to recognise the huge potential for digital technologies to improve how cities work, while going beyond the simplistic habits of 'technology push'. Successful smart cities of the future will combine the best aspects of technology infrastructure while making the most of the growing potential of 'collaborative technologies', and above all the citizens who power them.[3]

But how can this work in practice? How can cities effectively harness the power of citizens through digital technologies?[4] Drawing on examples from all around the world – from Beijing to Amsterdam, and from London to Jakarta – we investigate four emerging methods which are helping city governments to do this, powered by the growing ubiquity of smartphones, the increasing preference for online transactions, combined with the emergence of low–cost hardware and peer–to–peer technologies.

- **The collaborative economy:** connecting distributed groups of people, using the internet and digital technologies, to make better use of goods, skills and space. This is important in cities where resources, particularly space, are limited.

- **Crowdsourcing data:** People can use low–cost sensors to measure and create crowdsourced maps of their environments; city governments can crowdsource data from social media sites and sensors in mobile phones, as a supplement to city–wide Internet of Things networks.

- **Collective intelligence:** Decision making and problem solving are usually left to experts, yet citizens know a huge amount about their cities. New digital tools make it easier for people to get involved in policymaking, planning and budgeting, and this could help cities make smarter and more democratic decisions.

- **Crowdfunding:** People can connect with each other online to collaboratively fund community projects and city governments can use crowdfunding to make spending decisions that more accurately reflect the needs and wishes of citizens.

In the chapters that follow we look in more detail at the impact that these four methods are having on cities. In particular, in Part 3 we explore the outcomes they can help cities achieve, focusing

Madame Mayor

In Paris the city government will invest €2 million in vertical garden projects after they received over 20,000 votes as part of the 'Madame Mayor, I have an idea' participatory budgeting process.

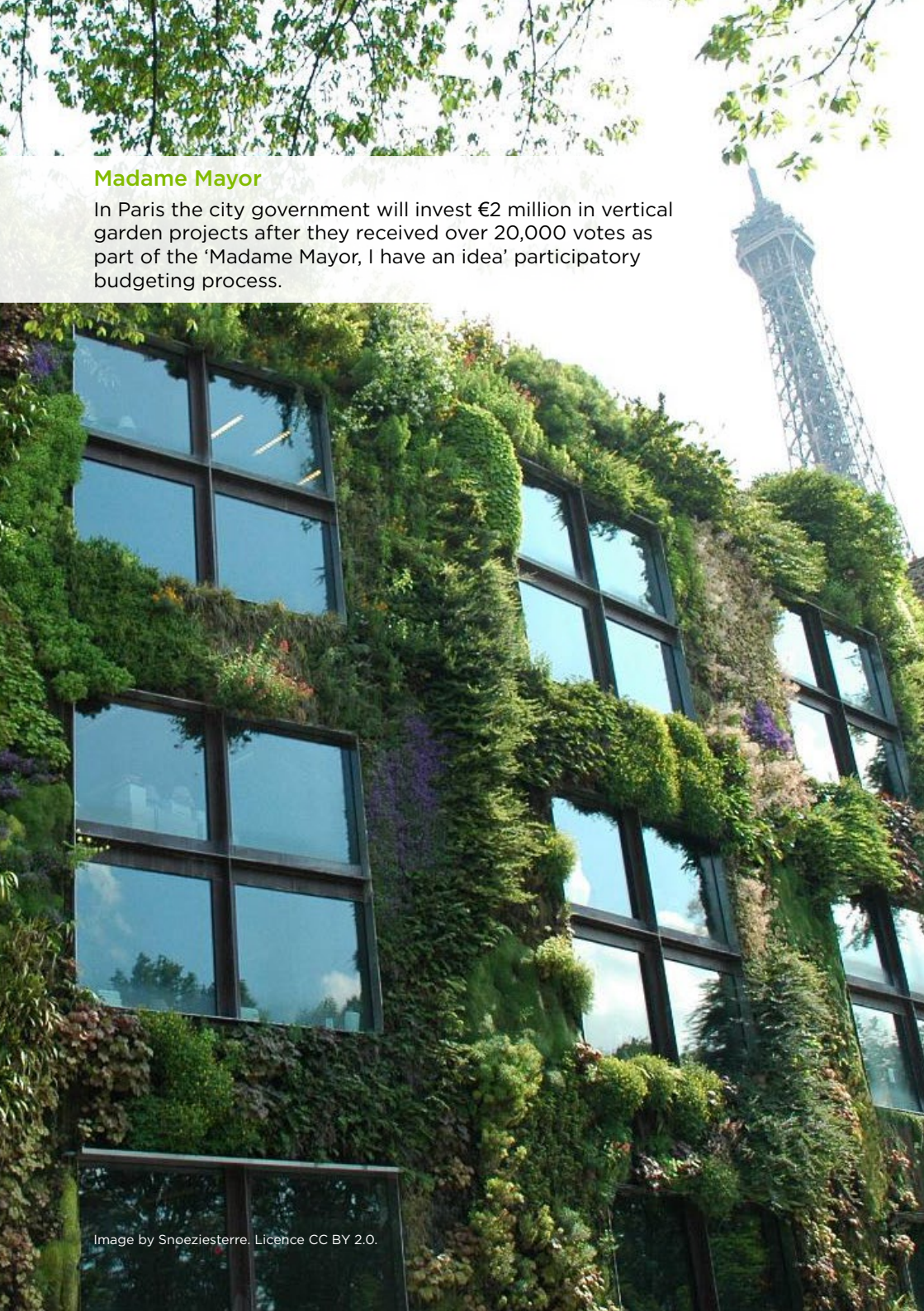


Image by Snoeziesterre. Licence CC BY 2.0.

on: smarter use of resources, smarter ways of collecting data and smarter ways to make decisions. As well as helping city governments work better, digital technologies can also empower citizens to directly address issues that matter to them. Part 4 looks at how digital technologies are helping people shape the future of their cities. Finally, Part 5 offers a vision for what people–centred smart cities might look like in the near future.

Many of the examples discussed in this report are early stage and would be easy to dismiss as tinkering at the edges. We explore the potential of these technologies and argue that to have a chance of helping cities address the tough problems they face, further investment and support are needed to generate evidence about which approaches are most effective, so that other cities around the world can adopt and build on the most successful of them.

Based on our research, we offer cities and national governments that are embarking on smart city pilots the following set of recommendations on how to do this.

How to run a people–centred smart city pilot

1. Set up a civic innovation lab to drive innovation in collaborative technologies

To explore the potential of using digital technologies to collaborate with citizens, city governments should set up civic innovation labs. One of the primary goals of these labs should be generating evidence about which models can most effectively harness the power of collaborative technologies– an area of work that is currently underdeveloped. The Seoul Innovation Bureau, and the Boston Mayor's Office of New Urban Mechanics (MONUM) are two examples of how a civic innovation lab could work. National governments should also consider setting up a civic labs network, to support knowledge sharing between individual labs.

2. Use open data and open platforms to mobilise collective knowledge

Smart city pilots should be open platforms, rather than proprietary projects, to tap into the collective brainpower of citizens and smaller companies. In practice, this means cities should:

- Support open source collaborative technologies, such as those developed by OpenPlans, rather than developing proprietary tools from scratch. This will contribute to the creation of common tools that all cities can draw on.

- Open up problem solving to citizens, using online tools that let people debate ideas and decide which of them get implemented rather than simply asking for suggestions. Better Reykjavik is an example of how to do this.

- Open up data to the public to help generate innovative solutions to urban challenges, but pay equal attention to finding productive uses for the data. For example, the Open Data Challenge series, a project by Nesta and the Open Data Institute brings businesses, community groups and city governments together to develop new ways of using city data.

- Involve smaller companies and civil society organisations in smart city pilots, as they are often behind some of the most inspiring digital solutions. The UK's Small Business Research Initiative (SBRI) helps small innovative companies access public R&D projects and could be used in smart city pilots.

3. Take human behaviour as seriously as technology

The smart city vision often fails to recognise the role that behaviour and culture play in the way cities work. And yet, new technologies and data streams will only be beneficial if they are accompanied by changes in culture – a greater willingness to engage with data, incorporate new technologies into traditional workflows and to embrace the potential of 'bottom–up' solutions.

Similarly, unsustainable patterns of living – such as the heavy use of resources or private transport – undermine data and technology–led efforts to make cities more sustainable. Alongside investments in hardware, city governments should promote the collaborative economy, where people can access the things they need, but only occasionally use. City governments should look to the example of Seoul, which has supported a range of collaborative economy initiatives.

4. Invest in smart people, not just smart technology

Without the ability to interpret data and understand how and why it is collected, there is a serious risk that it will be misinterpreted or ignored by city government employees. City governments should invest in training to give all staff a baseline understanding of data handling as well as hiring data specialists with advanced skills.

A smart cities pilot should also invest in digital skills for citizens. Successful programmes include: CoderDojo, a global movement of community–based programming clubs for young people, and 'hackathons' organised by the Singapore Government, which teach people how to use open data.

5. Spread the potential of collaborative technologies to all parts of society

Collaborative technologies require connected citizens. However not everyone uses a smartphone, has internet access or the time to engage with their city governments. Communities that are underserved by these technologies are usually the elderly, the young, the sick and the poor. When supporting and piloting collaborative technologies, cities should explore ways to expand their potential to these communities. Working with intermediaries including community groups, charities and NGOs could be one way to do this.

PART 2

SMART CITIES PAST AND PRESENT

Before looking ahead to the future, it is important to understand where the idea of the smart city comes from and what its promises and limitations are.

2.1 A brief history of the smart city

In 1997, the Smart Cities World Forum predicted that there would be 50,000 smart cities across the world by 2007.[5] While this vision never materialised the hype about smart cities hasn't gone away and there are now an abundance of smart city conferences, rankings, newsletters and consultancies. Investment in smart cities is also rocketing. According to Navigant Research the market for smart cities was worth $8.8 billion in 2014.[6] A review for the UK Department for Business Innovation and Skills (BIS) by Arup, the engineering, planning and consulting firm, predicted a global market for smart city technologies and services worth $408 billion by 2020.[7]

But what does it mean to be a smart city? The term has many interpretations but it most often refers to a high-tech city in the near future which includes the following elements:

- **More efficient city management** – A city-wide sensing network gives 'city managers' access to a real-time, integrated stream of data about the current state of services, infrastructure and energy flows in the city, which they can use to improve services and monitor and control resource usage. Intelligent software uses this data to analyse past trends and predict future problems.[8]

- **Economic development** – Local companies can build on the city's advanced infrastructure to become world leaders in advanced technologies and export them to cities around the world.[9]

- **Prestige** – Political leaders want their cities to rise up smart city rankings; they believe that smart cities will be attractive places for people and businesses to move to.[10]

Prominent attempts at creating smart cities include Masdar in Abu Dhabi, which aimed to use advanced technologies to become the world's first zero carbon city;[11] Songdo in South Korea, a city covered in sensors to improve sustainability and city management;[12] and Plan IT valley in Portugal, with its vision of an 'urban operating system' used to manage the whole city.[13] All of these projects were about creating new hi-tech cities from scratch, however none of them turned out as planned. Masdar City, which broke ground in 2008, is home to only a handful of buildings which make up the Masdar Institute of Science and Technology and around 100 student residents.[14] Plan IT valley ultimately wasn't built because of the financial crisis. Songdo is the most developed of the three but it is unclear whether the $35 billion spent on it has resulted in a city that is more sustainable and liveable than regular cities.[15]

Many of the champions of these early smart cities were IT companies who knew a lot about advanced networking technologies and data analytics but little about how cities work, which is why they focused on building new cities from scratch rather than engaging with the issues actual cities face. However, critics showed how impractical it would be to apply technology developed for utopian visions to real-world cities. As a result IT companies began to develop products and services to sell to existing cities. One way they did this was by trying to understand the challenges cities face. For example, in 2010, IBM set up its Smarter Cities Challenge, where cities could apply to have an IBM engineer seconded to them to work on real-world issues.[16]

Despite what companies have learned by working with cities, the tools on offer to city governments today are still cutting-edge technologies. For example, at the centre of the smart city offer is often a central control centre, where 'city managers' can monitor their cities on hundreds of computers and on giant wall-mounted screens, a practice drawn from traffic management but now being extended to the city and its various systems as a whole.[17]

Smart city visions so far have been confined to a handful of small scale or one–off pilots. However, this is set to change now that China and India have decided to fully embrace the concept. Since 2013, 193 cities or city districts in China have developed plans to set up a smart city pilot and in 2015 the Indian government announced that it would invest in 100 smart cities.

Smart cities are now at a turning point. Will they continue to focus on cutting edge technology or will they begin to consider the needs of people and the role that they can play in making their cities work better?

All the signs from China and India so far are that these pilots will focus primarily on the hardware aspects of smart city development. A note from China's National Development and Reform Commission states that smart city pilots should use intelligent monitoring and automated control systems to make city environments more liveable and 'integrated digital city management information systems' to make city management more efficient and precise. While there are many examples of cities across China using digital technology to engage citizens, some of which we discuss in this report, these are rarely included in official smart city plans.[18]

The four flaws with the smart city vision

Starting with technology rather than urban challenges
Work on smart cities often begins with the question: what uses can be found for cutting edge technologies? This is because the primary goal of smart city pilots is often economic development: supporting companies to create and commercialise technologies that can be sold to cities around the world.

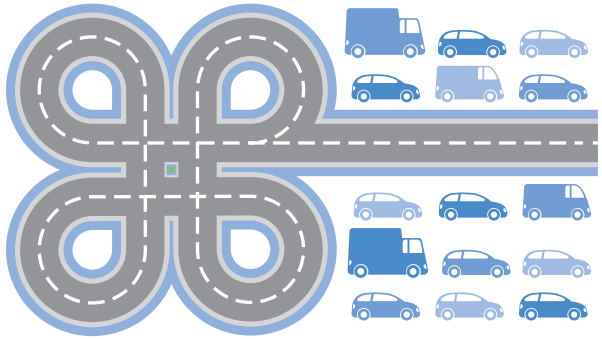
Insufficient use or generation of evidence
Despite the huge sums invested in smart cities worldwide, there is little published evidence showing that the solutions they offer help cities address real–world challenges. Installing sensors on infrastructure throughout the city or using data to predict traffic patterns might make cities more efficient and sustainable. Alternatively, it might cost more than it saves, especially when maintenance is factored in. Cities currently have no clear guidance regarding what technologies to invest in, and this will remain the case until smart city pilots start sharing their findings.

Lack of awareness of how others are trying to improve cities
The smart cities field is often too insular, with technologists talking to each other, but not linking to the work that others groups are doing to address urban challenges, such as those working within city government in areas from transport and planning to economic development and public participation.

Little role for citizen engagement
Many smart city strategies offer citizens little chance to engage in the design and deployment of new technologies. While citizens tend to be the implied beneficiaries of smart city projects, they are rarely consulted about what they want and their ability to contribute to making the city work better is often ignored.

A SHORT HISTORY OF SMART CITIES

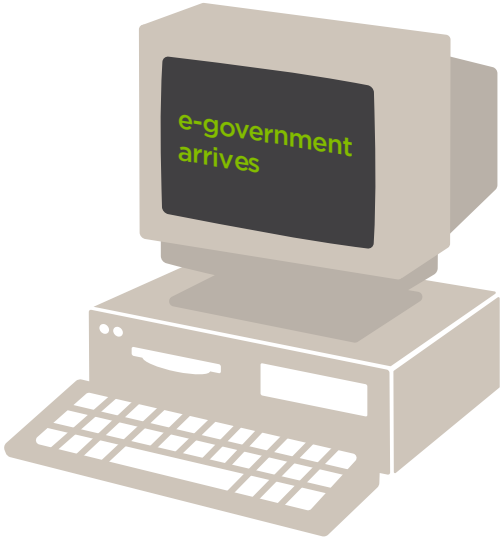
The first use of urban modelling tools
Transport planners began to use rapidly developing computer technologies to model transport flows in cities.



Building smart cities
The construction of entirely new technology driven cities such as Masdar and Songdo.

Present and beyond
Cities develop schemes such as Better Reykjavik to improve collaboration with citizens and tap into their collective knowledge.

1950 — 1990 — 2000



e-government arrives
Cities start using the internet and digital technology to improve internal government processes and to deliver public services.

The emergence of civic technology
Companies and NGO's begin developing digital tools such as FixMyStreet that let people map local issues and share these with government.

Repurposing cities to be smarter:
Pilots such as Smart Santander and MK Smart focus on making existing cities smarter through the large scale deployment of sensors across the city.

2.2 How are cities piloting smart city technologies today?

Hardware and infrastructure have always been a fundamental part of the way cities work.

In London, street lighting arrived in the mid–18th century, followed by telephone exchanges, a sewage system, public access to electricity, electric street lights, buses and the London Underground in the 19th century. In the 20th century, air travel, mobile phones, and the internet all made their mark on the city.

Now, new digital technologies are starting to have a profound impact on the way London works, from the congestion charging zone, which uses cameras and software to automatically recognise car number plates, and the London Air Quality Network, which measures and maps air pollution with digital sensing equipment. In the near future, a Transport for London pilot could see sensors being used at road crossings to make them safer for pedestrians. The city also plans to invest in modernised grids, known as smart grids, which are more efficient than older grids, and a 3D map of the pipes and cables under London's streets, which will make road maintenance and construction much easier.[19]

As London's evolution over the past few centuries demonstrates, cities are using technology to constantly evolve and adapt to suit the needs of the people who live and work in them. New technologies such as sensors and data analysis are part of this evolution. They are currently being piloted in cities around the world and their real–world impact can be understood through a number of technological trends.

The Internet of Things

Many cities are experimenting with the Internet of Things (IoT): objects embedded with sensors and the ability to communicate, sharing data with people and other objects. Here is a snapshot of a few of the cutting edge applications of IoT in cities today:

- **Barcelona smart bins:** A pilot using sensors on bins is testing whether the routes of refuse collection vans can be optimised by only sending them to full bins. The city estimates that the system could save 10 per cent on waste disposal.[20]

- **Glasgow intelligent streetlights:** This pilot is testing whether sensors on streetlights will save energy by allowing lights to automatically turn 'on' and 'off' when people walk past them at night.[21]

- **Singapore traffic management:** Singapore's Intelligent Transport System includes electronic road pricing (ERP) and sensors attached to taxis that help the government map traffic conditions. ERP, alongside regulation, has helped reduce the number of journeys by private car in Singapore.[22]

- **City wide sensing in Santander:** The Spanish city of Santander is home to one of the largest city–wide sensing pilots in the world with over 12,000 sensors collecting data on everything from parking space availability to air quality. According to the evaluation of the pilot, the project was about testing the concept of city–wide sensing networks rather than helping the city government make practical changes.[23]

- **Smart buildings in London:** In 2014 the Canary Wharf group launched the Cognicity Challenge, an accelerator designed to identify and pilot smart city technologies on the Canary Wharf estate. Technologies that the challenge is currently testing include Demand Logic, which aims to help businesses reduce electricity costs by intelligently monitoring electricity usage.[24]

The Internet of Things is likely to become an important part of how cities operate in the future, but it is not something that cities can currently invest in and expect to see immediate returns. Dr Ellie Cosgrave, a researcher at University College London explains that Internet of Things pilots taking place in cities around the world today are best seen as research tools: *"They are exploratory science, and that is ultimately good for cities."* But she also believes that these pilots are at a very early stage and *"there is often a false sense of usefulness about the data that they produce."*[25] For the

Image by Argonne National Laboratory. Licence CC BY-NC-SA 2.0.

Array of Things sensing pilot

near future at least, IoT pilots in cities are likely to be mainly funded by national governments and private companies, as in Glasgow, Milton Keynes, Chicago and across China.

One interesting trend in sensing pilots is an evolution from a closed, proprietary model to one based around modular platforms and open specifications. For example, in Chicago, the Argonne National Laboratory has partnered with the city government and Chicago University to create the Array of Things, a network of sensors which will be installed across the city. Rather than focus on developing proprietary sensors, the project instead seeks to create an open, modular network, which can accept sensors from a range of organisations. The researchers are also publishing open–source specifications for all of the software and hardware the project develops. This contrasts with earlier sensing pilots which focused on deploying proprietary sensors and shared little information about their technology or findings. According to Tomas Diez, founder of the Smart Citizen Kit, making pilots modular and open can make them much cheaper than proprietary pilots.[26]

Data: Integration, analytics and visualisation

Data is at the heart of many visions of the future city: for instance, information about traffic, the movements of people throughout a city and air quality. In the smart city vision, this data can be integrated, analysed and visualised to improve city management. In practice, this can work in a number of ways:

- **Data integration**
  Cities struggle with data integration. London for example has 33 boroughs that all generate their own data but share little of it with each other. A lesson from US cities, as analysed in *The Responsive City* by Stephen Goldsmith, is that the process of upgrading local government data systems is costly and time consuming.[27] While data integration can bring huge benefits, it requires significant changes in culture, as well as city staff who understand how to interpret findings.[28] However, in the smart city, data integration often becomes more about multi–million pound city control rooms rather than addressing difficult issues around skills and culture.

- **Data analysis and visualisation**
  Cities around the world, from Dublin to Singapore, are experimenting with data dashboards.[29] This involves displaying data relating to city life on a screen, usually using maps and charts. The goal is to provide decision makers in city government with detailed measures of city performance to help them make better decisions.[30] Dashboards are also paired with intelligent software that analyses the data to provide 'actionable insights.'

  The effects of data dashboards on decision making in cities aren't yet widely understood, but one critique is that their users are unaware of the subjective decisions that have gone into selecting and processing the data – for example, which metrics are included and which are deliberately left out.[31]

- **Predictive analytics**
  Many cities, particularly in the US, are experimenting with predictive analytics, which involves mining data relating to the past to identify patterns and predict future behaviour. This approach is adapted from industry where, for example, sensors on Formula One engines collect large amounts of data, which manufacturers can use to predict how the engines will behave in the future.[32] There are pilots exploring predictive analytics in several cities around the world, but only a few examples of real–world impact. Chicago has had some success in tackling its rat problems and this is one of the most cited examples.[33]

Singapore Smart Nation Programme

In 2014, Singapore launched its Smart Nation Programme to test advanced technologies in the city.

© TILT Photography

CASE STUDY

Singapore: The World's first Smart Nation

In 2014, Singapore launched its Smart Nation Programme, a vision that will see the city–state use data and advanced technology to drive economic growth and improve quality of life.

Like many cities, Singapore wants to attract companies to test their smart city technologies on the island. A few key attributes mean that Singapore will likely succeed here where other cities will struggle: Singapore is a compact city–state with world class IT infrastructure, a highly educated population and, crucially, only one layer of government, an advantage that many cities don't have.

As the population continues to increase, mobility is a big challenge for Singapore. Therefore, reducing the number of journeys made across the city by car is a major goal for the Government. To address this problem the Government is piloting an on–demand service that enables people to use their smartphones to order a bus. All of the requests by individuals will be analysed to create an optimal route. It is hoped that the service will be more convenient than a regular bus, but cost less than a taxi. The government is aware that it needs to make the system work for people, such as the elderly, who don't have smartphones, and is considering ways of tackling this issue alongside technical development.

Among its attributes, the Singapore Government is open to new ideas and is keen to study other projects taking place around the world and improve on these where it can, for instance through developing an open data strategy. However, it notes that some open data initiatives have been more successful than others in engaging citizens in actively using open data. To do this it has been running open data hackathons to encourage more civic participation in data collection and analysis and has recently started organising data literacy boot camps to build the skills of people who would like to work with open data.

Based on an interview with Tan Kok Yam, head of Singapore's Smart Nation Programme Office.

Lessons for city governments

When experimenting with Internet of Things sensing pilots and data projects, cities should:

- Realise that technology is only part of the equation – integrating advanced technologies and new data methods into traditional workflows will require difficult changes in organisational culture and investment in data skills, both basic skills for all employees as well as advanced skills for data specialists.

- Set up open sensing platforms which can accept sensors from a variety of organisations rather than building proprietary, closed projects. This will allow the city to harness creative ideas and technologies from different sized companies.

- Evaluate pilots and share the data with other cities around the world, so they know which technologies they should invest in.

PART 3

USING COLLABORATIVE TECHNOLOGIES TO ADDRESS URBAN CHALLENGES

Traditionally, community engagement has been confined to charities or interest groups lobbying city governments, or active citizens who have the time to attend community meetings. City governments have been experimenting with digital technologies to expand the number of people they engage with for a long time. The early 90s saw the development of 'e-government', a concept that includes everything from putting public services online to citizen participation in decision making.[34] More recently, the term Government 2.0 has emerged to describe the use of Web 2.0 tools to promote online collaboration.[35]

City governments have always found innovative ways of engaging citizens in addressing urban challenges. Examples include the famous participatory budgeting approaches used over many years in Porto Alegre, where citizens participated directly in deciding how a percentage of public money was spent, through to the hundreds of participatory budgeting experiments underway across the world; and the development of community visions and action plans, an example of which was Bristol's Choices for Bristol initiative.[34]

Now a new set of methods, powered by smartphones, the growing preference for online transactions, low-cost hardware and peer-to-peer technologies are enabling cities to work with citizens to find smarter ways to use resources, collect data and make decisions.

3.1 Smarter ways to use city resources: the collaborative economy

Efficiency is at the heart of all smart city visions. One way to achieve this is through the large scale deployment of sensors to measure and monitor infrastructure, for example monitoring water pipes to reduce leaks or monitoring and modelling traffic so it flows smoothly.

Another way for a city to promote efficient use of resources is to support digital tools that help people make better use of underused assets. For example, people own things they rarely use, they move around inefficiently in private cars, and many cities have unused and underused spaces.

Making better use of existing assets through sharing and collaboration is often defined as 'the collaborative economy.' Schemes that promote use rather than ownership have existed for a long time: car clubs, bike–sharing schemes and tool libraries, to name a few. Now, the internet and digital technologies have the potential to do a much better job of connecting distributed groups of people to make better use of these assets.[37]

Cars are one of the prime examples of an underused asset, with estimates showing that they are idle for 96 per cent of their life.[38] This has a tremendous impact on cities in terms of the amount of space that is dedicated to car parks. The UK as a whole has an estimated eight to 11 million regulated parking spaces, and a further 17 million unregulated ones.[39] Cars also require a city to dedicate a huge amount of public space to roads, compared to other possible uses. For example, in Singapore, a city–state where housing is extremely dense and expensive, roads take up 12 per cent of the total land area, compared to 14 per cent for housing.[40]

As well as intelligent software that makes traffic flow more efficiently and sensors and apps that help make better use of parking spaces, persuading citizens to make more sustainable transport choices could help address the negative impact cars have on cities.

Cities from Bremen to Shanghai have set up car clubs to encourage car sharing.[41] Rather than relying on the city governments or companies, new digital tools now allow people to connect directly with each other to rent out their cars by the hour. This peer–to–peer (P2P) model is growing in popularity, and there are now dozens of schemes in cities around the world. One example is Drivy, which has around 500,000 members and 26,000 registered cars in France and Germany. While many companies involved in the collaborative economy are worried about regulation, some forms of this could drive users to these services. For example, Drivy expects to have a bumper year in Paris in 2015, which has just increased the price of residential parking fees.[42]

As well as renting cars from individuals by the hour, people can also connect with each other to share car journeys. An example of this is Nebengers in Jakarta, which uses Twitter to match people who have space in their cars with people looking to share a ride. The Nebengers Twitter account has 83,000 followers and seven Nebengers employees re–Tweet around 1,000 requests for ride shares per day.

An estimated 600 cities worldwide have also set up bike–sharing schemes – another way of promoting an alternative to car ownership. Studies of these, in Barcelona, Paris, Lyon and Montreal, have shown that between seven per cent and thirteen per cent of users were replacing car, taxi or motorcycle trips.[43] The P2P model has also been extended to cycling, with services such as Spinlister that enable users to rent bikes from one another by the hour.[44]

Image by Andy Enero.
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Carpooling

Cars take up a huge amount of space in cities. A peer–to–peer scheme that helps people connect with each other to share cars could help address the negative impact cars have on cities.

Walk [Your City]

Walking is the most sustainable way to get around a city. It is also the most efficient and equitable way to use city space. Yet today, most major cities are designed far less for those walking than for motorised transport.

Digital technologies offer people a way to campaign for city streets built for them, not just cars. Walk [Your City] in the US produces signs that explain how long it will take to walk between popular destinations. These can be attached to lampposts or other structures, and also have a QR code which brings up walking directions, on Google maps, when scanned with a smartphone. As well as helping people to get around the city, it can be used to lobby governments to improve walkability.

Image: walkyourcity.org

Making better use of time, skills and everyday belongings

As well as helping cities be more efficient, bringing people together to make better use of their time, skills and belongings could help to strengthen communities, something that is rarely on the agenda for smart cities.

One example is Peerby, a website and app that launched in 2012 to enable people to request and share items with their neighbours. The company has over 100,000 users a month, mainly in Amsterdam, London, Brussels and Berlin. Other examples include BlockPooling, a social network for communities in Singapore, set up in 2013 with a grant from the Government, to enable neighbours to share belongings and offer or ask for services. The service has the twin goals of strengthening communities in Singapore and making more efficient use of resources.

Sharing Cities

City governments have an important role to play in changing cultures and promoting the idea of people accessing assets when they need them as an alternative to ownership. Sharing assets doesn't necessarily come naturally to people in cities in the 21st century, particularly when Amazon is only a click away. For instance, Nesta research found that only 15 per cent of people surveyed in the UK had either borrowed or lent something in the past year.[45]

Many city governments have realised the potential of the collaborative economy to help address the various challenges they face. Beyond individual projects, the term 'sharing city' has emerged to describe a more systematic approach to promoting the collaborative economy in cities. While there isn't yet a common definition or framework for what constitutes a sharing city, Berlin, Amsterdam, Seoul and a network of 15 US cities are all experimenting with various approaches.[46]

Sharehub, in Seoul, has been trying to promote public acceptance of the collaborative economy as part of the Sharing City Seoul initiative. Since it was launched in 2013, Sharehub organised a large public engagement and education campaign with conferences, seminars, reports and a book.[47] The initiative has certified 50 projects, ranging from local car–sharing companies to schemes that match students struggling to find affordable housing with elderly residents who have a spare room. The city government has given grants to a number of these schemes.[48]

As well as supporting collaborative economy organisations, cities could engage more actively in another area that has great potential: collaborative schemes that give the public access to city government assets, for instance car fleets, office space and tools. Since 2012, Seoul has opened up almost 800 public buildings for public meetings and events when they aren't in use.[49]

© Kyungsub Shin

Seoul Sharing City

Sharehub in Seoul is tasked with engaging the public in the collaborative economy as part of the Sharing City Seoul initiative. A big ear outside of City Hall symbolizes Mayor Park Won–soon's promise to listen to citizens' ideas and complaints.

CASE STUDY

Amsterdam Sharing City

In Amsterdam, if you need to use a car you can find one on peer–to–peer car rental service Snappcar. If you're planning to do a bit of DIY but don't want to buy a drill that you will only ever use once you can use Peerby to borrow one from your neighbours. And if you want to pick up a new skill, from languages to coding, you can use Konnektid to find neighbours who can teach you.

For Willem Koeman from the Amsterdam Economic Board, the city government can play an important role by helping to co–ordinate, promote and scale these activities. That's why the city government joined a coalition of partners in 2015 to launch the 'Amsterdam Sharing City' initiative, designed to make Amsterdam Europe's first sharing city.

Koeman believes that two ingredients are needed to make a sharing city initiative successful. The first is a strong technical foundation: *"Most collaborative economy services rely on the internet and digital technology. Amsterdam citizens are very well connected and digitally literate and this means that sharing platforms are very popular in the city."* The second factor is trust: *"Dutch citizens have a high level of trust both in each other and in local government."*

The sharing city initiative was initially promoted by ShareNL, a collaborative economy network and research organisation in the Netherlands.[50] ShareNL co–founder Pieter van de Glind believes believes that the main beneficiaries of the collaborative economy so far have been people who have good networks and own lots of things, and that the next step is to reach out to disadvantaged groups. There are already examples of this idea in practice in Amsterdam, such as Shareyourmeal, a website where volunteers can share meals with elderly people who aren't able to cook for themselves.

Based on interviews with: Pieter Van de Glind, ShareNL; Willem Koeman, Amsterdam Economic Board and Maaike Osieck, Amsterdam Smart City.

Lessons for city governments

Alongside investments in technologies that help cities waste fewer resources, city governments should support the collaborative economy to promote better use of the assets that both they and their citizens own. To do this, they should first consider a range of questions that will help them assess their starting point:

- What assets does the city government own that aren't being fully utilised – e.g. car fleets, office space, tools?
- What collaborative economy services are companies, entrepreneurs and community groups already offering in the city?
- Are there any organisations in the city that actively promote the collaborative economy that the city government could partner with (as was the case with the Amsterdam Economic Board and ShareNL)? If not, a city government could consider setting one up (as happened with the Sharing City Seoul initiative).
- Does the city have the necessary requirements to promote a digitally-enabled collaborative economy – for instance, an IT-savvy population and a culture of trust and sharing? City governments can increase the capacity for the collaborative economy by promoting these attributes.
- How will your city ensure that the collaborative economy can benefit all citizens, not just the digitally connected elite?

3.2 Smarter ways to collect data: crowdsourcing

To make smarter decisions city governments are looking to collect ever–increasing amounts of data about their cities. As well as finding new ways to aggregate and share data across city governments and using the Internet of Things to collect new types of data, crowdsourcing can be used to involve citizens in collecting data.

To crowdsource data, city governments can: use mobile applications to directly interact with citizens; work with companies already collecting data; mine social media; or work with researchers who are creating low–cost, distributed sensors.

The biggest potential benefit of crowdsourced data is that it could enable governments to carry out data collection much more cheaply than they currently do. With governments and researchers striving to overlay cities with new sensor networks, it's often forgotten, as Anthony Townsend argues in *Smart Cities: Big Data, Civic Hackers, and the Quest for A New Utopia,* that cities already have a city–wide sensor network, in the form of increasingly popular smartphones.[51]

In the US, Boston has been experimenting with this potential with Boston Street Bump, an app developed by the Office of New Urban Mechanics and Boston University researchers. The software uses the accelerometer in mobile phones to sense when the driver of a vehicle hits a bump in the road, and then sends this data back to the city government.[52] While

Image by San Francisco Bycicle Coalition Photostream. Licence CC BY-NC-ND 2.0.

Fixmystreet

There are a range of apps that allow citizens to map city issues, from potholes to abuse by city officials. In the case of the FixMyStreet, some cities have taken it one step further and integrated it into the city workflow.

it is was primarily designed to identify potholes, data from the app showed that bumps were four times more likely to be sunken manhole covers. As a result, the city has now fixed over 1,250 of the worst instances of these.[53]

Another option for city governments is to work with companies to crowdsource data. One example of this is Google's Connected Citizens Program, where Google shares data from its Waze navigation app with ten cities around the world, including Jakarta and Tel Aviv, to help them better understand traffic conditions.[54] The advantage with this approach is that cities don't have to build a user base for their own apps. Instead, they can access a ready-made audience and large amounts of pre-existing data.

As well as being passively monitored, citizens can also directly report issues to their city governments. They have always been able to do this on the phone, in writing, or at community meetings, and city governments often have websites where issues can be reported. However, this frequently requires more time than citizens are ready to spend, and issues are usually limited to a number of narrow categories.

To address these challenges, cities are creating apps and services that make it easy for citizens to report issues, for example by enabling them to submit a photo from their smart phone of a pothole they have encountered, or to Tweet a complaint about a bus that hasn't arrived. These services take their lead from Fix My Street, a website setup in 2007, which enables residents to report problems to local councils by marking them on a map. Fix My Street was developed by the NGO MySociety, and several councils in the UK – as well as cities around the world, including Helsinki in Finland – have incorporated it into their workflow.

In addition to helping cities cut costs, citizens can also use issue-reporting systems for a range of other purposes. For instance, in Manila, they can report abuses by city officials through the 'I am part of the solution' app,[55] and in India, women can use the Safecity website to report and map sexual assaults. In these cases, the maps also become a resource for activists who can lobby their governments to deal with these issues.

CASE STUDY

Putting people at the heart of data collection in Jakarta

In 2014 Jakarta launched its smart city plan. But rather than focus on the Internet of Things and big data, the organisers decided that it would focus on citizen engagement.[56] To do this, the Jakarta provincial government developed the Smart City Platform which consists of an issue–reporting app, a crowdsourced flood map and a crowdsourced traffic management tool.

Citizen reporting with Qlue

Like many similar platforms around the world, Jakarta's citizen reporting app, Qlue, lets residents upload photos of issues they have spotted around the city, anything from potholes to abandoned cars. Reports appear on a map of the city, which local officers can use to identify issues that need fixing. The reporting system is still in beta phase but initial results show that it is making life much busier for city officials as departments that receive reports have to respond to issues within a week otherwise they receive a sanction.

Crowdsourced flood mapping with Petajakarta

Floods are a major issue in the city, with thousands of people forced to abandon their homes every year. The Regional Disaster Management Agency (BPBD) has developed an online map to give citizens and city staff information about flooding, based on reports that it receives from officers in the field. While the map is very accurate it takes a long time to update.

Another option that Jakarta has started to experiment with is crowdsourcing flood reports. It is a surprising fact that Jakarta Tweets more than any other city in the world. This produces a huge amount of data for researchers and city officials to analyse. PetaJakarta, a joint project between researchers at the University of Wollongong in Australia and the Jakarta provincial government, was set up to take advantage of this.[57] The software uses Tweets about floods to create a real time, crowdsourced map of flooding in the city. Accuracy is always an issue of concern with crowdsourced data. Another innovative feature of the platform

is its partnership with Twitter: if a resident of Jakarata Tweet's the word flood, Twitter will send them a message asking for verification. If the person confirms they were trying to report a flood, the message will go on to the crowdsourced map. BPBD is now trying to integrate the system into its existing workflow.[58]

Crowdsourced traffic management with Waze

A recent survey found that Jakarta has the worst congestion of any city in the world. The city government is searching for new ways to help manage traffic and one avenue they are exploring is crowdsourced traffic reports.

With around 1 million monthly users of Waze, the Goolge-owned navigation app, Jakarta was an ideal candidate for the Waze Connected Cities program. City officials hope that the data sharing agreement between the city and Waze will help alleviate congestion in the city by giving drivers and city traffic managers better data.

For Eko Haryadi, deputy head of the Office of Communication and Public Information in the Jakarta provincial government, the value of a people-centre approach to smart cities is obvious: *"We don't have as many resources as cities in rich countries so this makes us much more efficient."*[59] Despite this, companies visit Jakarta regularly hoping to persuade the city to spend millions on cutting-edge smart city technologies, from intelligent transport systems to advanced data modelling software.

Based on an interview with Eko Haryadi, deputy head of the Office of Communication and Public Information, Jakarta provincial government.

Crowdsourcing environmental data

Many researchers are creating sensing equipment to crowdsource environmental data, these technologies could soon be used to supplement data collected by the city, with the benefit of being much cheaper than professional equipment. While data collected by professionals is highly accurate, a large enough number of low–cost sensors will produce results that are good enough to allow policymakers to make decisions about air quality.

One of the most promising examples of this technology is the PiMi Airbox developed by Tsinghua University.[61] Individual devices achieve a much higher level of accuracy than similar low–cost sensors and they also upload all the data they collect to create a crowdsourced map of indoor air pollution in Beijing.

While researchers get a crowdsourced map of the air pollution in the city, volunteers who host the kit are more interested in what it can tell them about the air quality in their homes. The ability of the device to measure PM 2.5, the smallest and most dangerous type of particulate matter, is one of the reasons that it has proved so popular: over 500 people volunteered to host a PiMi Airbox within a day of the project being launched.

Air pollution in Chinese cities

Smog is a major issue for many cities across China. Citizens are starting to use low–cost sensors such as the PiMi Airbox to measure and map air pollution in their cities.

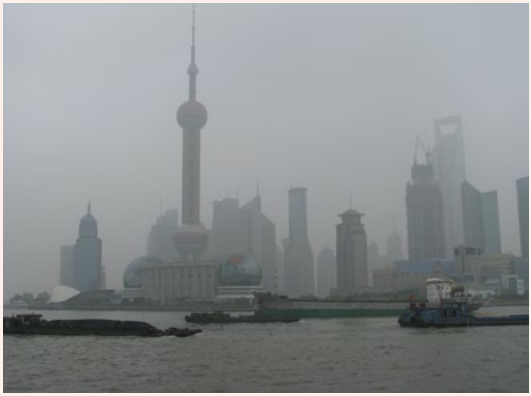

Image by Peter Dowley.
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CASE STUDY

Wo Ai Beijing (I Love Beijing) online map and mobile app

In China, smart city pilots are mostly about hardware and infrastructure. But Song Gang, Director of the Science and Technology Information Center of the Beijing City Administration Bureau, believes that culture, not technology, is the main challenge: *"Upgrading the hardware is not difficult at all. It is way more difficult to change people's mindsets and get them to embrace new systems."*

New systems that Song Gang's team have been experimenting with include 'I love Beijing', a mobile app and online map that city maintenance staff use to crowdsource reports about issues such as potholes and broken streetlights. The app grew out of a successful pilot project where unemployed people were given hand–held digital devices and asked to report issues they spotted around the city.

The app also includes a map of over 600 informal food markets in Beijing. Many of these markets are operated informally by groups of neighbours and it is difficult for the city government to keep track of their opening times, what they sell, and other useful information. Beijing residents can use the 'I Love Beijing' app to score and comment on the quality of the markets, correct inaccurate information and add new information, such as the opening of new markets.

Beyond city management, digital technologies are helping people who have left Beijing to maintain a cultural connection with the city. For example, the Tuanjie lake district of Beijing has created 3D Tuanjie Lake, a website where citizens can display photos of their artwork, including paintings, calligraphy and ceramics. The Tuanjie Lake district government office also posts photos of events in the community such as Children's Day celebrations. This feature is especially popular with family members and former residents who now live overseas as it gives them a way to connect with the community.

Based on an interview with Dr Song Gang, Director of the Science and Technology Information Center of the Beijing City Administration Bureau.

Lessons for city governments

Crowdsourcing data could provide a cheaper alternative to city–wide Internet of Things networks by making use of technologies people are already using – for instance, mobile phones and social media. To further explore the potential of this, cities should:

- Implement websites and apps that allow citizens to send feedback and report issues to the city government. Keep in mind that citizens will quickly become disengaged if they feel their input is being ignored. To make sure this doesn't happen, cities should develop feedback functions in their reporting apps.

- Explore ways to crowdsource data from social media as a supplement to city–wide sensing networks. Successful examples include PetaJakarta's crowdsourced flood map.

- Keep in mind that crowdsourcing data from citizens will result in a picture of the city that is less than complete. This is because the people that engage with this are usually the most affluent, educated and connected segment of a city's population.[62] More experimentation and evidence is needed to identify the best ways to crowdsource data from a broader group of citizens that are more representative of the whole community, but in the meantime cities should be aware of the limitations of crowdsourcing data.

- Cities should also be aware that the use of these technologies alone is not enough, and that the difficult work is not creating the technology but incorporating it into their existing workflow.

3.3 Smarter ways to make decisions: collective intelligence

One of the fundamental goals of the smart city is to help city governments make better decisions, for example by using big data and predictive analytics. But another way for a city to make smarter decisions – which we define as decisions that that more effectively respond to the needs and priorities of the community – is to use collaborative technologies to engage with citizens directly on issues such as planning, budgeting and policymaking.

Cities have always consulted their citizens, through public meetings, exhibitions or surveys. However, the numbers reached have generally been small and unrepresentative of the overall community. Now, new digital tools offer cities the chance to involve a much wider group of people in these processes, and for these people to have a much more direct impact on their cities.

Engaging with citizens also enables city governments to make more legitimate decisions. For example participatory budgeting can help to improve citizen understanding of how government works, and the difficult decisions that have to be made. Engaging citizens early in the planning process can prevent a backlash when the full extent of a new proposal becomes widely known.

Participatory planning

Experts dominate city planning, with developers, architects and city employees making key decisions. There are many critiques of this approach. For example, geographer György Enyedi notes: *"Planners (experts) have a limited knowledge of local problems. Statistical data on noise pollution or on crime rate cannot express exactly how local people feel about these conflicts or how the suggested solutions fit into their cultural traditions."*[63]

Studies show that most community engagement in planning involves a very low level of participation and that this is centred on the provision of information.[64]

When citizens are consulted by city governments it is usually done in an analogue way: community meetings, exhibits in public spaces or sending letters to those that might be affected. As a result, city planners often fail to reach many of those that will be affected by a change in their community, and decisions can lack legitimacy. In China, for example, developers often run several rounds of public consultation and are still confronted with violent protests once construction work begins.[65]

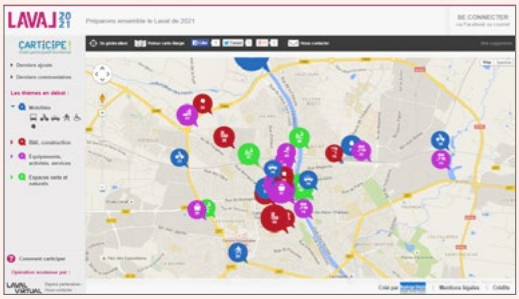
Digital tools offer cities the chance to engage citizens at a much deeper level and to involve a wider section of the population in planning. While there are examples of online planning consultations in cities around the world, it is often thought of as an added extra rather than a key requirement.

For example, since 2004, local authorities in the UK have been required to publish a statement that explains how they will involve the community in the planning process. Most of these statements focus on offline engagement methods – for instance, public exhibitions and letters sent to local residents – and only include online consultation as a non-essential addition.[66] Also, when planning processes are moved online they generally aren't user-friendly: they are badly designed, full of jargon and overload people with information.

Planning innovations

The challenge is to understand how new digital tools can help planning become more democratic, and how the collective intelligence of citizens can be harnessed to help cities make smarter decisions. As with the other methods we look at in this report, there is a growing list of cities and developers who are doing good work in these areas.

When architecture firm Archi-Tectonics and crowd-investing company the Prodigy Network wanted to create a plan to redevelop the centre of Bogota, they set up a simple, easy-to-use website, 'My Ideal City', where the city's residents could make suggestions and comment on proposals. In terms of the numbers



Carticipe

of people reached, the initiative was a huge success. Helped by a daily slot on the local radio where residents could debate issues with planners, the site received over 100,000 suggestions about projects or changes that people wanted to happen in their city.[67]

Maps are another way to involve citizens in planning. French platform Carticipe is a website where people can indicate changes they would like to see in their city on a map, debate issues and vote for their favourite ideas. It has been used by the Government in Laval to collect suggestions for a local development plan, and by a local newspaper in Strasbourg to stimulate debate ahead of municipal elections.[68]

Games can also be an effective tool which can engage wider communications in planning. Minecraft, a game simply described as 'virtual Lego', has been used around the world, for example by UN Habitat in Nairobi to facilitate community engagement in planning. It works well due to the basic skills needed to play the game.[69]

Many tools used in planning consultations today are based on proprietory software. Yet these tools are often expensive as cities have to pay for them to be built from scratch. An alternative is to support open-source tools. One example of this is OpenPlans, a not-for-profit organisation in the US that aims to create a set of open-source tools for citizen engagement in urban planning, so that cities can build on tools that other cities have built rather than creating brand new tools.[70]

Next Bangalore

NGOs can also use technology to engage residents in planning. Next Bangalore is an initiative organised by the MOD Institute in Bangalore and Germany's Next Network to create a community vision for the city's Shanthinagar neighbourhood.[71] It combines a website where residents can submit and debate ideas with more traditional forms of engagement, including events and an exhibition space. The initiative has helped to create a vision of what residents want their area to look like, as well as capturing their everyday needs and problems.

One key aspect of the above was the identification of abandoned urban spaces as a major issue of concern, as they are often used as places to dump rubbish. Residents were asked to help map these spaces and this was used to start a conversation about what should be done. The NGO now plans to work with city planners to try and get residents' ideas adopted by the city government.[72] In addition to this, the project has also developed a pilot app that will enable people to map abandoned urban spaces via smartphone and SMS in the future.

© Next Network

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Better Reykjavik

In Reykjavik citizens can use the Better Reykjavik platform to submit ideas on anything from school opening times to new playgrounds.

Participatory budgeting

Involving citizens in spending decisions, known as participatory budgeting, is one way to draw on the collective intelligence of people to make smarter decisions.

Participatory budgeting started in the Brazilian city of Porto Alegre in 1989 and has been used to fund a huge range of projects around the world ever since, from water supply networks in Ilo, Peru, to allotments in Seville, Spain, and lamppost refurbishment in San Antonio, Chile. It has since spread to an estimated 1,700 municipalities worldwide.[73]

Could new digital tools offer governments the chance to engage more people in participatory budgeting? All the evidence so far shows that digital technologies are best at reaching new audiences, and so should be used to supplement traditional participatory processes rather than replace them. For example, the main participants in the Estonian city of Tartu's 2013 online–only participatory budgeting pilot – where citizens could vote on how they wanted to spend 1 per cent of the city budget – were 30–to 36–year–olds, a demographic that doesn't usually attend community meetings.[74]

The Mayor of Paris, Anne Hidalgo has been studying the forerunners in this area closely and has tried to improve on them with Paris' own participatory budgeting scheme, 'Madame Mayor, I have an idea', which will allocate €500 million to projects proposed by citizens between 2014 and 2020, and claims to be the largest exercise of this kind in the world. The pilot phase of the campaign,

launched in 2014, received over 5,000 proposals. While votes and proposals could only be submitted online, the campaign also organised physical meetings across the city to ensure that older people weren't left out.[75] Budgets for the project have been divided among the 20 districts in Paris based on economic need, with the poorer, outer suburbs being allocated 15 times the amount put aside for central Paris.[76]

Civic crowdfunding and smarter spending decisions

Like participatory budgeting, crowdfunding – where large groups of people collectively fund projects through small financial contributions – can be used by city governments as an innovative way of funding urban projects and involving citizens in spending decisions. This was the case in Rotterdam where local frustration with the lack of safe opportunities to cross a highway led to citizens crowdfunding the Luchtsingel wooden footbridge, with each donor getting their name on a plank on the bridge. The idea proved so popular that it attracted subsequent funding from the city.

While most civic crowdfunding projects are initiated and funded by citizens, cities have sought to use crowdfunding through investing in 'match funding' schemes. In practice, this means cities will fund projects if they meet their crowdfunding target. In London, as part of its Pocket Park project, the city provided £5,000 of match funding for small park projects if citizens could raise the first £5,000. Elsewhere, Plymouth also set aside £60,000 to match fund local projects on Crowdfunder, a UK–based crowdfunding website.

Other projects start with funding from the city government and turn to crowdfunding to validate the opportunity. Milan is currently testing out this approach: it plans to launch a €430,000 fund which will pay half the costs of a series of largely socially–orientated projects, with the rest left to citizens to fund through a crowdfunding website.[77] Citizinvestor and Neighbor.ly in the US are examples of other organisations operating similar models.

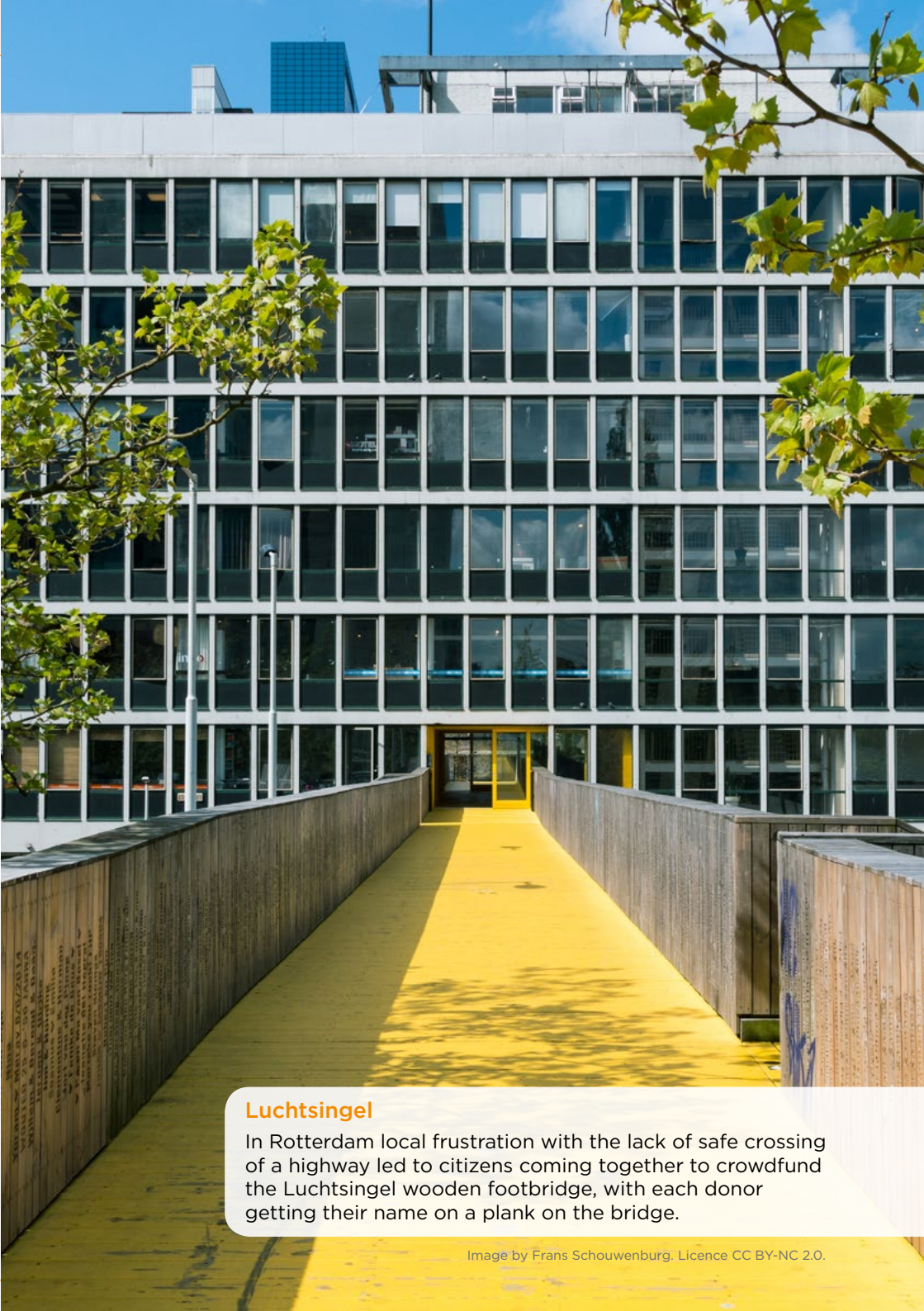
Participatory policymaking

One of the main challenges for Paris and other similar participatory budgeting schemes is deciding what to do with all the suggestions they receive. The International Association of Public Participation's 'Spectrum of Public Participation' framework lists four levels of civic engagement: inform, consult, involve, collaborate, and empower.[78] Online citizen engagement often stops at the 'involve' level, collecting ideas from citizens without allowing them to debate these with city officials or to directly take decisions about which projects get implemented.

Many ways have been tried to move online engagement up the public participation spectrum. At a national level, Open Ministry in Finland facilitates the crowdsourcing of legislation, allowing citizens to post policy ideas on their website. Following feedback from other citizens and volunteers, policy experts then create a draft bill, which is put to a public vote. The Finnish parliament has agreed to debate and ultimately vote on any bill that gets more than 50,000 public votes. This has so far led to one citizen bill – a proposal that makes it possible for same-sex couples to get married – getting a 'yes' vote from parliament.

An example of how this kind of project works at the city level is Better Reykjavik, developed by the non-profit Citizens Foundation in Reykjavik, Iceland. It allows citizens to propose, debate and vote on ideas for improving the city and its services. Each month the city council debates the 10 to 15 most popular ideas. Between 2012 and 2014 almost 60 per cent of citizens were estimated to have used Better Reykjavik, and the city spent €1.9 million developing more than 200 projects based on citizen ideas.

One issue with participatory policymaking websites is how to integrate them with existing policymaking processes. For example, the Finnish Government recently refused to debate a batch of crowdsourced bills that were developed on Open Ministry.[79] To help with integration, Nesta's D-CENT project is currently testing prototypes for digital democracy at the local and national level across Europe, with the aim of developing a set of open-source tools which governments will be able to incorporate into their existing policymaking processes.[80]



Luchtsingel

In Rotterdam local frustration with the lack of safe crossing of a highway led to citizens coming together to crowdfund the Luchtsingel wooden footbridge, with each donor getting their name on a plank on the bridge.

Image by Frans Schouwenburg. Licence CC BY-NC 2.0.

Lessons for city governments

There is huge potential for city governments to make smarter decisions by tapping into the collective intelligence of citizens. To explore this potential cities should:

- Create open–source, user–friendly websites where citizens can engage with the planning process.
- Agree to debate issues in the city council which have been proposed, debated and received a minimum number of votes on online platforms. Better Reykjavik and Open Ministry are good examples of how to do this.
- Give citizens the power to decide how a percentage of the city's budget is spent, moving beyond a 'suggestion box' model to one where citizens are given genuine scope to debate and decide which projects get implemented.
- Make clear to citizens the kind of response they will receive if they participate in these processes. Cities risk alienating citizens if they feel that their suggestions and participation aren't valued.

PART 4

HOW COLLABORATIVE TECHNOLOGIES ARE HELPING PEOPLE SHAPE THE FUTURE OF THEIR CITIES

As well as giving city governments smarter ways to use city resources, collect data and make decisions, digital technologies can also empower citizens to directly address issues that matter to them: they can use low–cost sensors to map and measure their communities, to raise awareness of problems and lobby governments for change; they can crowdfund projects they care about; and volunteer their time and skills to improve their communities.

Raising awareness: environmental sensing

In the previous chapter we saw that researchers are creating low–cost sensors that may have the potential to supplement official air quality measurements in the future, but at present there are still reservations about the accuracy of the data they produce. But for John Lynch from the UK's Future Cities Catapult, data accuracy isn't the main issue: *"The question is, do we want to measure air quality or do we want to change air quality? If you put a £50 piece of kit in someone's hands you are more likely to achieve change – it's about mobilising people not feeding back data to official air quality measurement channels."*[81]

This is the goal of the Smart Citizen Kit, which combines low–cost sensing technology with an online crowdsourced map of air pollution in cities across the world. According to founder Tomas Diez, *"it's about empowering people to take their city back."*[82]

One issue with sensing kits is that there are often high barriers to use as they require a certain level of technical knowledge. Intermediaries can play an important role in giving citizens the skills to engage with these technologies. For example, Manchester

and Amsterdam have both experimented with creating smart communities around the Smart Citizen Kit. In Amsterdam, the Waag Society – an independent foundation exploring how emerging technologies can address social challenges – and the Amsterdam Economic board brought 100 volunteers together to gather data and learn about their local environments by using the kit as a measuring tool. At the end of the project 45 people decided to buy the kit so they could carry on using it.[83] Frank Kresin, Research Director at the Waag Society explains: *"What started as a technical project turned into a social project: it brought a group together – which stayed together afterwards and found new uses for the technology."*[84]

Wheelmap

Wheelmap is an online map which lets people share information about how accessible places are by wheelchair. To date, users have mapped 500,000 locations across the world.

Another example of citizen sensing is DustDuino, a low-cost, open-source air pollution sensing project from Public Lab, a non-profit which develops tools for environmental exploration and investigation. It is much cheaper than other sensing kits because it only focuses on one type of air pollution: particulate matter.[85] The advantage of DustDuino is that in can be built relatively easily by people with DIY skills, using open-source instructions and parts. The devices have been used to measure air quality in Ulaanbaatar, Mongolia, a city with severe air pollution and a sparse network of professional sensing equipment.[86]

Citizen sensing projects from China

In 2014, a photograph of people running the Beijing marathon in heavy-duty facemasks spread around the world. The person responsible for the air quality monitoring account of the US embassy in Beijing once described an extremely severe air quality reading in the city as 'crazy bad.'[87] As a result, apps that tell people the official air quality readings are some of the most popular in the city. Beyond this, students and entrepreneurs are creating low-cost sensing equipment which people can use to measure their own air quality:

- Air. Air! is a portable air quality monitor which connects to a smartphone and was succesfully funded on Kickstarter.
- Design students at Tsinghua University developed an air pollution monitor that gradually changes colour as air quality worsens, making technical information easy to understand.[88]
- Art can also be a powerful way to advocate for change. In Beijing, designers created FLOAT 'smart' kites to map air pollution over the city and raise awareness of the problem.[89]

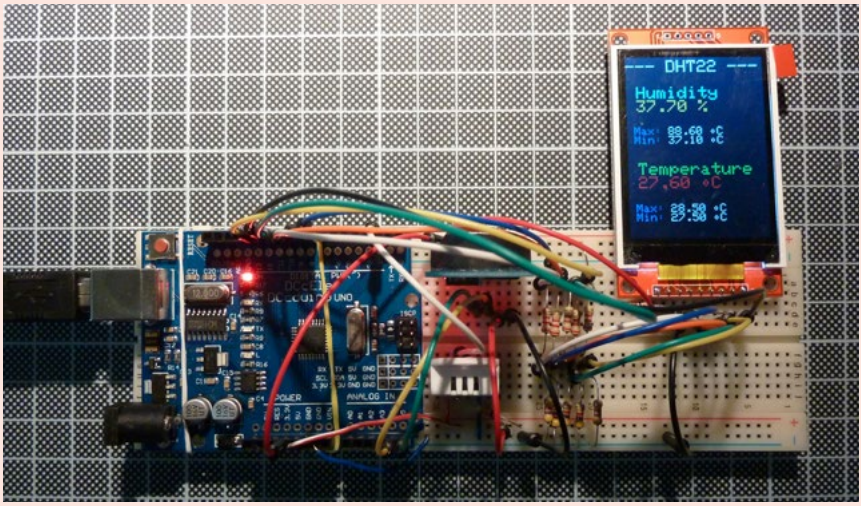


Image by J.C.Barros. Licence CC BY 2.0.

Crowdsourced maps

In the age of Google maps, it's easy to think that we have perfect maps of cities. Yet many of the most important aspects of a city aren't mapped. This is where crowdsourced mapping can help.

For example, Wheelmap, an online map developed by the German NGO Sozialhelden, enables people to share information about how accessible places are by wheelchair.[90] Launched in 2010, users have mapped 500,000 locations across the world.[91] Another example is Clean Air Asia's WALKability app, which people can use to score places based on how easy they are to walk around and upload the scores to create a crowdsourced map.[92]

With both of these NGOs, the maps have two functions: one is to let people know how accessible the city is, the other is to change the way city governments think about accessibility and give NGOs and activists a tool to use to lobby for improvements.

Funding projects that matter to people: civic crowdfunding

As well as helping cities make smarter decisions, as we discussed in Part three, civic crowdfunding offers citizens a way to directly initiate and collaboratively fund projects in their communities, from buildings and parks to events and community centres.

Image by Di Cavalcanti, Lu. Licence CC BY-NC 2.0.

Colour+City

Collaborative platforms help people make better use of resources, which can make the city more sustainable, connected and fun. The Colour+City platform matches those with a wall they would like decorated with street artists looking for places to paint.

Spacehive is a crowdfunding company in the UK that has pioneered much of the work in this space. Examples of typical Spacehive projects include: Stockwell Urban Oasis, which raised around £900 online (plus £900 at a community event) for an educational forest garden for children in Stockwell, London; and Minehead EYE youth and community centre in Somerset, which raised over £5,400 to build a climbing room for young people.[93]

High-profile examples of civic crowdfunding projects such as the +Pool in New York, or the BD Bacatá Skyscraper in Bogotá are not representative of how civic crowdfunding is used today, or its true potential. The +Pool enjoyed a high-profile media campaign and received donations from around the world.[94] The BD Bacatá Skyscraper is less about citizen crowdfunding than a new type of investment opportunity.[95]

In contrast to these examples, the potential of civic crowdfunding is much more local, with residents funding low-budget projects that really matter to them. For example, out of 58 successfully funded projects listed on the Spacehive website, 20 (36 per cent) had a funding target of less than £1,000 and 41 (70 per cent) had a goal of £10,000 or less.[96]

Crowdfunding slum upgrades in Mumbai

In developing countries, civic crowdfunding is mainly a form of philanthropy, rather than local communities funding their own projects. One example is the Homegrown Cities project in Mumbai, which is trying to develop a better way to upgrade slums. In India slum upgrading is usually achieved through clearing away informal housing, and building blocks of flats. These flats are often very poor quality, and in recent years there have been several instances where they collapsed, killing and injuring dozens of people. The Homegrown Cities project, which was successfully funded on Indiegogo, promotes the idea of using local builders and materials, combined with international best practices, to create high-quality, affordable housing within existing communities.[97]

CASE STUDY

Engaging citizens with data and technology in London

The London Datastore is a website that provides access to data about the city. In May 2015 the site had over 580 datasets on everything from household waste to childrens' tooth decay, and reservoir levels. The point, according to Andrew Collinge of the Greater London Authority (GLA), is not just to catalogue all of London's data but to turn the site into a home for data–led innovation in the city. There are two challenges the datastore has to overcome to make this happen. The first is getting access to data and harmonising it. Unlike New York with its five boroughs, London has 33 boroughs. Each is a separate political and service entity, and all have different levels of expertise and commitment to opening up the data they collect.

The second challenge is around finding productive uses for public data. Opening this data up will only lead to positive outcomes – social or economic – if there is a community of people and businesses that have the skills to effectively use it. One way that cities can help create such a community is through open data challenges, and the GLA has recently announced plans to launch a series of these.

Beyond open data, the GLA is using technology to harness people's collective intelligence with its Talk London website, a citizen engagement tool that enables residents to debate the big issues London faces, from crime to housing. Future plans for the site centre on encouraging deeper levels of community engagement, where residents will be given the opportunity to get involved in policy and service design.

Based on interview with Andrew Collinge, Greater London Authority.

Collective action

Another benefit of civic crowdfunding for communities is its ability to mobilise volunteers to work on community projects. According to US civic crowdfunding service Iobby, 53 per cent of donors volunteer their time to help the projects they're supporting, in addition to donating money.[98] There are also now a range of digital technologies that enable citizens to connect with each other, discuss and develop community projects and volunteer their time and skills, without necessarily having to make a financial contribution.

Examples include Change by Us, a website where residents can discuss, propose and join projects, mainly involving community gardens and renovating disused urban spaces.[99] It is now available in several US cities and in Amsterdam. Another example, I Clean India, is a combination of an issue–reporting app and a tool for city governments across India to mobilise volunteers to get involved in city cleaning drives.[100]

Peerby

In Amsterdam, London and Brussels, over 100,000 people use the Peerby website to connect with their neighbours online to share everyday items such as drills and bicycles.

Image by Hiro Putra.
Licence CC BY-NC-ND 2.0.

Lessons for city governments

The various ways that communities are using collaborative technologies – sensing and mapping their communities, funding projects and connecting with each other to bring projects to life – could have an important impact on cities, from making them more sustainable to building stronger communities. To support these initiatives cities should:

- Provide training opportunities to citizens to help them understand and use technology and data. One successful example of this was the Amsterdam city government's support for communities to learn how to use the Smart Citizen Kit.

- Work with NGOs and community groups to broaden the reach of sensing, mapping, crowdfunding and collective action to communities that wouldn't usually engage with these processes.

- Explore opportunities to build 'bottom up' collaborative technologies into the city's workflow. For example, city governments in Reykjavik and New York now officially support Better Reykjavik and Change by Us, both of which were developed by community organisations.

PART 5

A VISION FOR PEOPLE-CENTRED SMART CITIES

As we discuss throughout this report, collaborative technologies have the potential to make cities smarter and improve urban life. However, at present many of the most promising examples are early stage and small scale and if integrated at all, sit at the periphery rather than at the core of smart city strategies.

To have a chance of helping cities address some of the tough problems they face, we argue that further investment and support are needed to generate evidence about which approaches to using collaborative technologies are most effective. Cities then need to share these lessons so that other cities can adopt and build on the most successful approaches.

In the introduction of this report we set out five main recommendations on how cities can better achieve this.

1. **Set up a civic innovation lab to drive innovation in collaborative technologies.**

2. **Use open data and open platforms to mobilise collective knowledge.**

3. **Take human behaviour as seriously as technology.**

4. **Invest in smart people, not just smart technology.**

5. **Spread the potential of collaborative technologies to all parts of society.**

How might this look in a real-world city in the near future? Below we discuss what an alternative smart city vision for Beijing, one of the world's largest and most rapidly evolving cities, might look

like, one that combines the best of 'top down' city-led approaches while making the most of the growing potential of 'bottom-up' technologies, and above all the citizens who power them.

Smart Beijing – 2025

Sustainability and transport

In 2025, air pollution sensors embedded in every smartphone and the low-cost sensing kits that everyone has in their flats will allow the city government to create a crowdsourced map of air pollution in the city. Community groups will also use these maps to raise awareness about how the choices people make, such as driving to work, contribute to this problem.

Navigation apps used by drivers will give the city a detailed picture of the flow of traffic in the city, allowing city planners to map the most popular journeys and offer better public transport options. On-demand buses with efficient, bespoke schedules created by mapping the movements of bus passengers that use the bus reservation app will criss-cross the city at almost the same speed and level of comfort as taxis. Building on this, the Sharing City Beijing initiative will partner with peer-to-peer car sharing, ride sharing and bike sharing schemes to offer alternatives to individual car journeys.

The Sharing City scheme will also work with citizens to map unused assets, from car fleets to buildings, and build open-source websites and apps to help citizens access these and promote their use.

Urban development

Beijing's new 2025–2050 master plan, based on a series of crowdsourced community plans, will set out a new vision for the city's future development, based on the needs and everyday challenges its residents face. It will also require future urban

development projects to seek significant engagement with citizens, using collaborative technologies to call for ideas, promote debate and empower citizens to take decisions about projects that will affect them.

The city will also set aside 5 per cent of its budget to allow citizens to propose and debate urban development projects, from parks and community centres to improved cycling infrastructure and decide which of these projects get implemented.

Inclusive and open government

To encourage citizen participation, the city will open up the majority of the data it collects and appoint data officers to work with citizens, businesses and NGO's on making the most of city data. Companies that provide services to the city will have to comply with open data standards and where possible digital tools developed by or for the city will be open source to encourage further collaboration.

To further encourage uptake and usage of data the city government will organise data dives and hackathons with anyone interested in analysing city data and invest in schemes that build capacity in the city among NGO's, citizens and businesses to work with data.

Evolving the smart city

As cities evolve new urban issues arise. To keep evolving the smart city and developing solutions to new urban issues, the city will set up a civic innovation lab where citizens, technologists and city officials can work together on developing new ways to address urban challenges. The lab will also mobilise entrepreneurs and social innovators to develop and test practical solutions.

ANNEX

What else is Nesta doing to make cities smarter?

CITIE (City Initiatives for Technology, Innovation, and Entrepreneurship)

CITIE (City Initiatives for Technology, Innovation, and Entrepreneurship) – a collaboration between Accenture and Nesta has analysed and benchmarked how 40 cities globally act across nine policy areas: Regulator, Advocate, Customer, Host, Investor, Connector, Strategist, Digital Governor, Datavore, diagnosing their current performance, and through case studies with city leaders shine a light on best practice. Together CITIE provides city governments with a playbook for developing implementable policy and contributes to fostering a network of cross–learning between cities. CITIE's insights can help city governments make incremental innovations in their policy environment which can yield a transformational impact on a city's innovation ecosystems and catalyse new growth.**www.citie.org**

Mapping 'sharing cities' across the globe

We are beginning to see a number of cities across the world developing strategies and activities that seek to generate social, environmental and economic value from embracing and adopting the sharing economy and the principles that underpin it. The term 'sharing city' is being adopted by many cities, from Amsterdam to Seoul, to describe this practice. Building on CITIE, Nesta will create a set of indicators for a sharing city, and use this to map sharing cities across the world.

For more on Nesta's sharing city work see:
www.nesta.org.uk/blog/8–steps–toward–sharing–city

Digital Social Innovation (DSI)

Funded by the European Commission, Nesta led a large research project into Digital Social Innovation (DSI). The project explored how digital technologies help civic action: mobilising large communities, sharing resources and spreading power. To understand the state of DSI in Europe the project developed **www.digitalsocial.eu** which was used to map 1,000+ organisations working on DSI, their characteristics and collaborative networks between organisations.

D–CENT: The role of technology and online platforms in increasing democratic participation

D–CENT is a Europe–wide, EU–funded project creating decentralised and privacy–aware applications for direct democracy and economic empowerment. Together with citizens and developers, the project is exploring the creation of a decentralised social networking platform for large–scale collaboration and decision making.

Open Data Challenge Series

In the Open Data Challenge Series, we are running seven challenge prizes that invite businesses, startups and individuals to develop innovative solutions to social issues using open data in areas such as Crime and Justice, Energy and Environment, Education, Housing and Food. One example of a winning solution is MoveMaker, an app which uses open housing data to help social tenants house swap.
nesta.org.co.uk/project/the-open-data-challenge-series

Interviewees

Alejandro Rodriguez, Project director, Geografia urbana (Columbia)

Alexandra Deschamps-Sonsino, Founder, Design Swarm

Andrew Collinge, Assistant director of intelligence and analysis, Greater London Authority

Ben Hawes, Smart cities policy lead, UK Department for Business Innovation and Skills

Corrin Wilson, Smart Cities Project Manager, UKTI

Ellie Cosgrave, Research Associate, Liveable Cities Programme, UCL

Eko Haryadi, Deputy head of the Office of Communication and Public Information, Jakarta provincial government

Frank Kresin, Research Director, Waag society

Helen Bedford Olsen, Head of Communications Local Digital Campaign, DCLG

John Lynch,Project Lead, Product and Service Design, Future Cities Catapult

Jonny Voon, Lead Technologist – Internet Technology, Innovate UK

Lorraine Huddson, Research associate, Open University

Maaike Osieck, Communications Manager, Amsterdam Smart city

Mikele Brack, Project director, Pivotal Innovations

Niraj Saraf, Lead Technologist for Urban Living, Innovate UK

Pieter Van De Glind, Co-founder, Share NL

Poon King Wang, Director, LKY Centre for Liveable Cities (Singapore)

Rebecca Rumbul, Head of Research, My Society

Shang Jin, Editor, China Information Times

Song Gang, Director of the Science and Technology Information Center of the Beijing City Administration Bureau.

Tan Kok Yam, Head, Smart Nation Programme Office (Singapore)

Tomas Diez, Founder, Smart Citizen Kit

Willem Koeman, ICT cluster manager, Amsterdam Economic Board

Yodit Stanton, Founder, Opensensors

About the authors

Tom Saunders is Senior Researcher – International Innovation at Nesta. His work focuses on helping governments learn from innovations around the world, with a particular focus on how cities can use digital technologies to address urban challenges, principally through collaboration with citizens and community generated innovations. Tom also leads on Nesta's research and engagement with China and much of Nesta's work in South East Asia, particularly Indonesia. He has advised the UK government on innovation collaboration with ASEAN countries and the Chinese government on community generated low carbon innovation and is co–author of *China's Absorptive State: Research, innovation and the prospects for China–UK collaboration*.

Peter Baeck is Principal Researcher – Public and Social Innovation at Nesta. He focuses on social innovation and innovation in public services, with a particular focus on the role digital technologies play in enabling new types of social innovation and civic participation. Peter has also led on much of Nesta's research into crowdfunding and P2P lending as an innovative way of financing products and services, as well as government innovation, and is co–author of *i–teams: The teams and funds making innovation happen in governments around the world*.

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