WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

Global Agenda

Data Driven Cities
20 Stories of Innovation

Prepared by the Global Future Council on Cities and Urbanization

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Forewords

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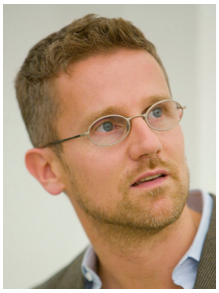

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The world is filled with data. Every time we send a message, make a call or complete a transaction, we leave digital traces. We are quickly approaching what Italian writer Italo Calvino presciently called the "memory of the world", a full digital copy of our physical universe. Data is already a key component for business, but today it has entered the public sphere and is moving into our cities. This has made it more important than ever to understand the consequences of data, notably how it affects people's lives.

This is the goal of the "data stories" we have collected in this report. "Big data" is far more than just a matter of quantity; it is a "big promise" for our cities as they face the challenges and opportunities that the Fourth Industrial Revolution is producing. To scale-up some of the opportunities outlined in this report, it is crucial that an increasing number of people have access to data and participate in a multistakeholder discussion about its use. As much as possible, big data should become "open data" to have a true, profound impact on our cities. If this can be achieved, then people in cities worldwide will have the opportunity to invent increasingly compelling data stories.

Foreword

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With two-thirds of the world's population expected to live in cities by 2050, the question of how to make cities work better for their inhabitants has never been more urgent. If harnessed, the data that permeate cities can answer this question in myriad ways, and serve to inspire solutions for navigating the technological, social and economic changes of the Fourth Industrial Revolution. The potential to collect, analyse and apply urban data to achieve deeper insight on city preparedness, makes this a critical moment for cities to embrace and encourage the use of data to drive their development.

Data-Driven Cities: 20 Stories of Innovation seeks to highlight how cities have achieved this. It builds on the popular work of the Top 10 Urban Innovations, published by the Global Future Council on Cities and Urbanization in 2016. It also inaugurates the work of the Cities and Fourth Industrial Revolution project, which will become a key part of the Forum's Cities portfolio. This is focused on empowering cities to use data in defining and measuring their preparedness for the Fourth Industrial Revolution.

An aim of Data-Driven Cities: 20 Stories of Innovation for the Fourth Industrial Revolution is to inspire reflection on the vast possibilities of data to improve the liveability, governance and sustainability of the world's cities and begin the discussion on where action is possible

Introduction

The Fourth Industrial Revolution is set to erupt in cities throughout the world. Bits are meeting bricks as the internet enters the spaces we live in, becoming the Internet of Things. The results will impact most aspects of our lives, raising questions of urgent concern. Which dimensions of cities will be most affected? What will be the impact on citizens? How should urban policy change? And, most importantly, how can cities prepare for looming disruptions and opportunities?

This report by the World Economic Forum's Global Future Council on Cities and Urbanization looks at these questions through a very specific lens: data. The convergence of the digital and physical worlds is producing an immense amount of information, as much information was created in 2016 as in all of previous human history.

Citizens leave their digital trace just about everywhere they go, both voluntarily and involuntarily. Each phone call, text message, email, social media post, online search and credit card purchase is recorded and stored in the cloud. When cross-referenced with each user's geographical location, data harnessed at this scale offers a means of describing, and responding to, the dynamics of the city in real time.

Not all data is created equal, and its variety is also part of this report:

- "Opportunistic data" is collected for one purpose and then used for another: think about data owned by cellphone companies to run their operations, and used by transportation companies to better understand urban mobility.
- "Purposely-sensed data" shows the power of cheap and ubiquitous sensors that can be deployed ad hoc – in private buildings or in public spaces – to better understand some aspect of urban life.
- "User-generated data" comes from engaging people, such as through social media platforms or crowdsourcing. Every tweet, Facebook post, or Flickr upload can provide valuable information to better understand today's cities and society.

The following pages present stories from cities all over the world, selected by a diverse panel – from academia to industry to government. These are stories of innovation that is occurring in the developed and the emerging world, from the top down and the bottom up, design-led efforts and new policy initiatives. The common thread that connects them: the challenges cities face as they approach the Fourth Industrial Revolution.

The stories illustrate how data can be used to improve the experience of the built environment – whether by public entities, large corporations, startups, or private citizens. Using data, we can better understand the digital world in ways that enable us to transform physical space. We can develop solutions to tackle some of the most pressing issues – from energy to waste, from water to mobility, from urban design to citizen participation.

The stories presented in this report are classified into five themes: people, governance, infrastructure, economy and environment. They provide a glimpse of the impact of the Fourth Industrial Revolution on cities through the unprecedented lens of data – arguably, our newest urban common.

People

"What is the city but the people?" asked Shakespeare. Today, new technologies are giving citizens more opportunities to have a say in the functioning of their communities. They are opening up a space – in the convergence of the physical and the digital – in which people can organize to reclaim what French philosopher Henri Lefebvre called their "right to the city". The data stories collected in this chapter are linked by their interest in provoking behavioural change, whether people-to-people or government-to-people.

Unlike the broad, sweeping projects of the past, digital changes can happen without heavy infrastructure. They are not necessarily determined by governments, but can arise from bottom-up actions. Public institutions should want citizens to get excited about urban innovation. Beyond the installation and control of hardware, if the right platforms can be developed, people can really be the ones to transform the cities they own.

1. Showing at a glance if city services are meeting their targets

What

CityScore is an online dashboard showing how Boston's city government is performing against its targets in 24 areas – from sign placement to emergency call response, from garbage collection to pothole repairs. Daily activity updates make performance and progress transparent to the public and city administrators. A single, combined number summarizes how the administration is performing overall.

Why

The metrics measured by CityScore are a gauge of how well the city government is serving its citizens. Tracking performance against targets enables problem areas to be quickly identified and remedied, and offers citizens the opportunity to hold administrators to account. It would historically have been much more challenging to collect and review the necessary data manually.

How

Some data is automatically collected by sensors, such as the percentage of buses arriving on time. In other cases, city workers use their mobile devices to record when they have completed a task. Then, this data is automatically aggregated and divided by the target figure to generate a daily, weekly or quarterly score: above 1 means the city is exceeding its targets, below 1 means it is falling short.

Potential

An open-source version of the CityScore platform is available on GitHub for other cities to adopt and adapt, offering the potential to engage citizens and improve services around the world.

Useful links

https://www.boston.gov/cityscore

TOPIC	DAY	WEEK	MONTH	QTR
311 CALL CENTER PERFORMANCE	0.99	0.9	0.92	0.88
GRAFFITI ON-TIME %	0.74	0.62	0.61	0.69
MISSED TRASH ON-TIME %	1.19	1.17	1.18	1.17
PARKS MAINTENANCE ON-TIME %	0.36	0.97	1.03	1.02
POTHOLE ON-TIME %	1.25	1.05	0.95	0.9
SIGN INSTALLATION ON-TIME %	1.15	1.11	0.89	0.83
SIGNAL REPAIR ON-TIME %	1.25	1.16	1.11	1.13
STREETLIGHT ON-TIME %	0.52	0.58	0.86	0.8
TREE MAINTENANCE ON-TIME %	1.25	1.24	1.22	1.22
ON-TIME PERMIT REVIEWS	0.52	0.69	0.85	0.87
LIBRARY USERS	1.02	1.18	1.17	1.13
BPS ATTENDANCE	0.98	0.98	0.99	0.97
BFD RESPONSE TIME	0.96	0.91	0.92	0.9
BFD INCIDENTS	1.18	1.13	1.1	1.06
EMS RESPONSE TIME	0.83	0.98	0.95	0.94
EMS INCIDENTS	1.16	1.08	1.06	1.06
PART I CRIMES	1.3	1.53	1.39	1.29
HOMICIDES (TREND)	-	-	6.17	3.08
SHOOTINGS (TREND)	0.41	1.6	1.72	2.29
STABBINGS (TREND)	3.06	2.14	1.7	1.5
311 CONSTITUENT EXPERIENCE SURVEYS	-	1.25	1.14	1.13
CITY SERVICES SATISFACTION SURVEYS	1.25	0.84	0.87	0.91
TOTALS	1.07	1.1	1.31	1.17

Boston's cityscore dashboard lets citizens know how well their city is performing on a wide range of metrics

2. An easier way to get help if you're harassed on public transport

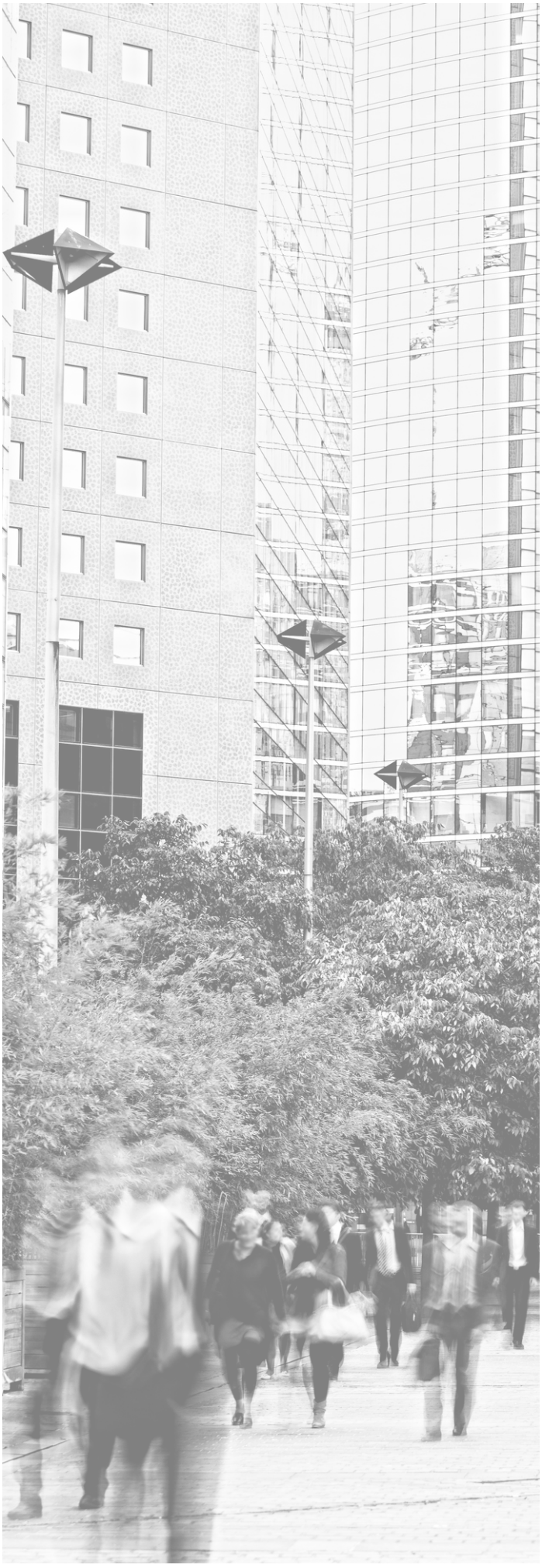
What
Bájale al Acoso is a mobile platform used to report sexual harassment cases that occur on the municipal public transportation system in Quito, Ecuador.

Why
Some 83% of women who live in Quito consider the public transportation unsafe – far more than the 6% who make a formal complaint about sexual harassment. The platform is part of *Quito, A Safer City for Women and Girls*, a joint initiative of UNIFEM and Patronato San José, a local social foundation.

How
The platform uses SMS, as most women who use public transport do not have a smartphone. Anyone who feels at risk of sexual harassment can send an SMS describing her concern and where she is: a central service aims to respond within three minutes, for example by activating an alarm on the bus or dispatching a public official to wait at the next bus stop. Six "safety spots", with specialized staff, are located at the main bus stations; 220 bus drivers have been trained in responding to incidents of harassment.

Potential
By collecting data, the platform promises to inform better policies and make responses more efficient, thus optimizing predictive systems and better at targeting police attention. It also raises awareness of the problem of sexual harassment on public transport, which should contribute to changing social attitudes about its acceptability.

Useful links
http://www.bajalealacoso.com



3. Complain about city services – and get notified of results

What

The “Our City” portal makes it easy for citizens in Moscow, Russia, to submit requests or complaints about city services – for example, about street cleaning, garbage collection, or potholes – and receive updates when the issue is addressed. The portal also shows a map of where citizens have submitted requests and complaints.

Why

Citizens often do not know what services the city provides, or how to request them. Administrators may not be aware of problems unless citizens report them, and may not receive due credit for addressing them.

How

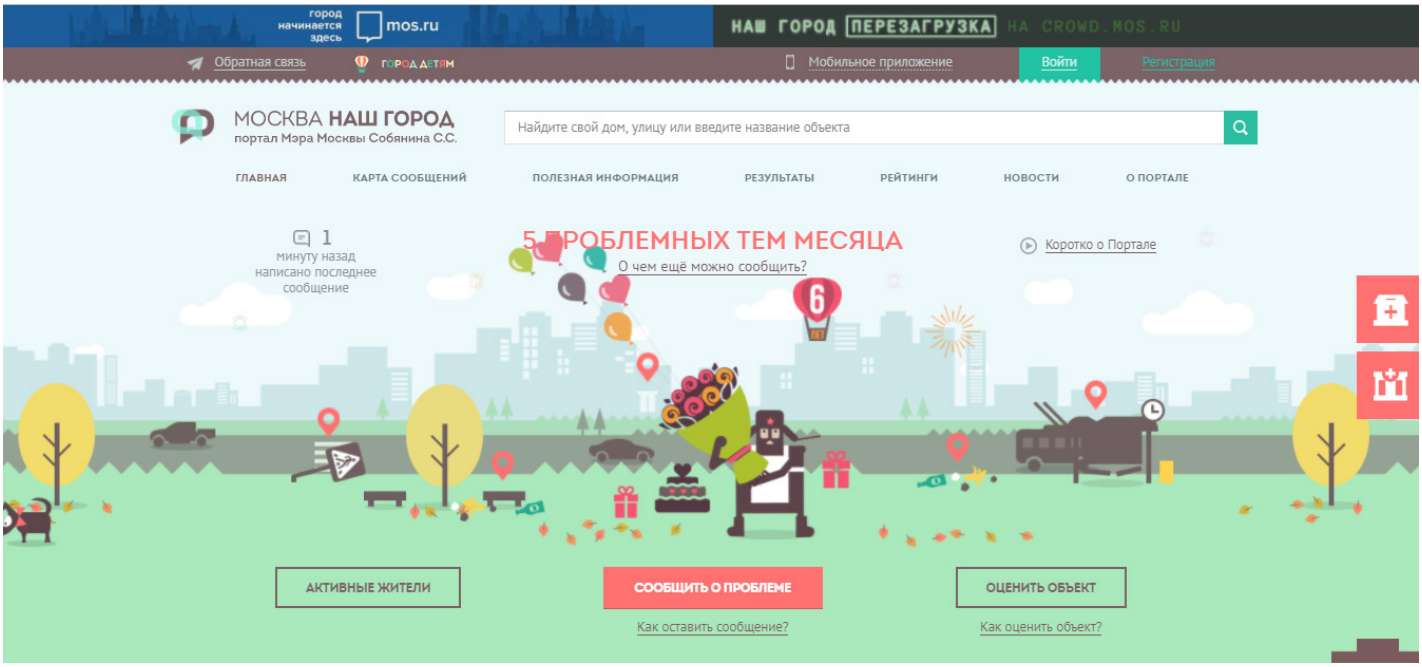
Citizens can submit complaints via the online portal or a mobile app. In each case, the citizen briefly explains the problem and, optionally, attaches photos. Then, the case is automatically assigned to a subcontractor or city authority that has strict rules regarding time frames for resolution. Finally, citizens receive a personalized response when the problem is fixed, typically with photos of the result.

Potential

As well as improving the efficiency of infrastructure and services, the data generated by such platforms could help to prevent problems by informing better on-time maintenance or management decisions.

Useful links

https://www.mos.ru/en/news/item/13030073/ (eng)



In its first year, Our City portal has already registered nearly 1.1 million users, and delivered over 2 million complaint resolutions

4. Better productivity through understanding local workplace cultures

What

As the global economy continues to prioritize innovation and knowledge work, understanding the drivers of employee performance and a balanced workplace becomes a more critical component of economic growth and discovery. Data from multiple surveys featuring more than 11,000 office workers in different markets around the world has uncovered new insights into how different working conditions are needed to optimize human performance in different regions and cultures.

Why

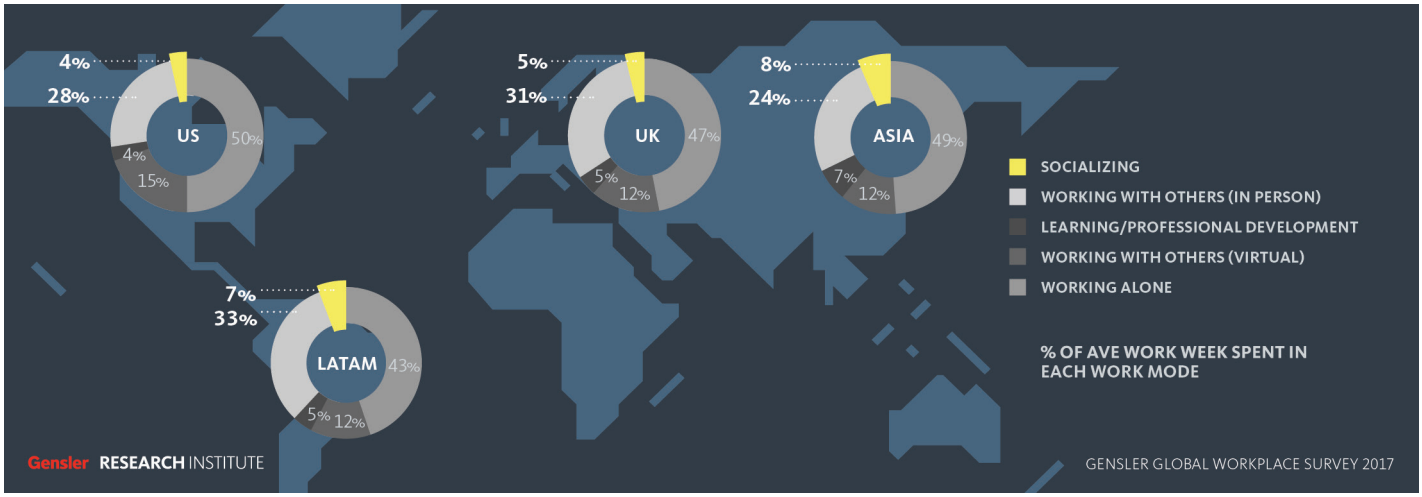
There have long been cultural stereotypes about how office workers in different cultures like to work differently. North Americans, for example, seem to prefer individual focus work, while Latin American and Asian knowledge workers are more likely to collaborate to improve productivity. But is there truth in the stereotypes? Understanding if and how different dynamics shape work environments in different cities could enable employers to optimize workspaces according to local culture.

How

The workplace surveys gathered data via an online panel of over 11,000 office workers distributed evenly across the US, UK, Asia and Latin America using Gensler's Workplace Performance Index platform. Respondents have worked in an office environment at least some of the time, and for a company of at least 100 people. The obtained data was analysed by an internal research team using higher order inferential statistical methods and tools such as multiple regression and ANOVA, along with descriptive analytical methods such as quartile and segmentation analysis.

Potential

City governments and business leaders can use the data from such surveys to foster productivity and innovation by tailoring strategies toward the needs of the local population, rather than importing business and cultural models that seem to work elsewhere.

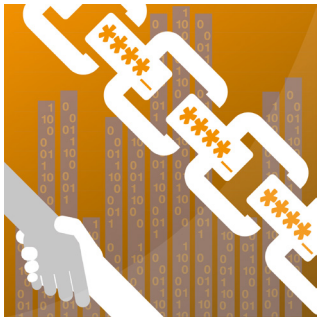


Gensler Workplace Surveys develop an understanding of how and where people are working, and how well their spaces support that work

Economy

The Fourth Industrial Revolution will change how we produce and consume, and its impact on city life will be dramatic – from new forms of manufacturing to artificial intelligence and the sharing economy. Digitally controlled machines, 3D printers, open-source software and new sharing devices allow almost everyone to draw and give shape to their own products, ideas, houses, or working spaces, often using data to personalize their experience of the built environment.

As they strive to attract foreign and direct investment, talent, skilled labour and startups in the era of the Fourth Industrial Revolution, cities must remodel their economies to become attractive for what Elizabeth Currid-Halkett calls the “aspirational class”. Members of this multiform, peripatetic class are interested in “inconspicuous consumption” – for example, good schools, wellness facilities, and a thriving cultural and food scene.



5. Leading the way on blockchain – can it improve city services?

What
Dubai launched a citywide blockchain strategy in 2016. Beginning with pilots in 2017, it is exploring the extent to which implementing blockchain technology in government services can improve their efficiency. The strategy also aims to create an enabling environment for startups in the blockchain industry.

Why
Many believe that blockchain – the technology behind cryptocurrencies such as Bitcoin and Ethereum – has the potential to transform large sectors of governance and the economy by eliminating the need for centralized third parties to monitor and validate transactions. However, analogously to the early days of the internet, exactly how the potential of blockchain will play out remains a matter of some uncertainty.

How
Visa applications, bill payments, license renewals, health records and property transactions are among the services the city is starting to put on the blockchain, moving towards integrating blockchain technology as much as possible by 2020. The strategy to encourage the private sector to adopt blockchain technology includes accelerators and competitions, with a council comprised of approximately 50 members from private sector and the formation of cross-border partnerships.

Potential
Dubai's government hopes to save significant amounts of time and money by adopting blockchain, and its experiences should be transferable to other cities.

Useful links
http://www.smartdubai.ae/dubai_blockchain.php

6. Opening up data to improve policymaking and encourage innovation

What
Dublin and Melbourne are among cities leading the way in making their data publicly available for businesses and citizens to use, as well as providing tools for visualization and analysis. Melbourne decided to make available data it has collected for many years on areas such as land use and pedestrian movements; Dublin's website Dublinked is a partnership of local authorities and the National University of Ireland.

Why
City governments use data to inform the making of policies and decisions. Opening up that data to the general public is intended to drive innovation and collaboration in the development of new urban solutions. Dublinked, for example, has led to the formation of startups and launching of new software applications.

How
The data comes from various sources: in Melbourne, examples include revaluations of property for taxation purposes and remote digital counting of pedestrian movements. Dublinked has over 250 data sets covering areas from planning and land use to recreation and amenities; public and private companies can also share their data on the website, alongside the data provided by local authorities.

Potential
As more cities emulate Melbourne and Dublin by creating an open data culture, more citizens and startups are expected to find ways to use the data to improve city services and create economic and social value.

Useful links
https://data.melbourne.vic.gov.au/about
http://dublinked.ie/

7. Understanding city economics by analysing bank data on spending

What
Researchers at the MIT Senseable City Lab used bank data to model, visualize and predict spending patterns in Spanish cities and regions, including indicators on the amount of spending, type of spending, type of individual and individual mobility in a special project called Urban Lens. An app allows users to compare the distinctive signature of each region and aggregate data across regions.

Why
Economic models have been failing to adequately predict and explain macroeconomic trends. This project closes the gap between models of micro behaviours and macro phenomena to elucidate how bigger economic patterns can be understood by utilizing data about individual economic transactions.

How
Anonymized data on millions of financial transactions is provided by BBVA, which has ubiquitous banking infrastructure in Spain. The model was validated by comparing it with official socioeconomic indices at the provincial level: the correlation proved to be strong.

Potential
By improving understanding of microeconomic patterns at city level, and enabling comparisons across cities and across time, Urban Lens can be used to inform urban planning, policy-making and business decisions.

Useful links
http://senseable.mit.edu/urban-lens/

8. A seamless public transport experience – paying by card or face recognition

What
The Indian city of Ahmedabad introduced an automatic fare collection system and integrated transit management system to offer seamless journey planning and payments– including informal public transit, such as shared cabs and auto-rickshaws. Yinchuan in China, meanwhile, has deployed a facial recognition system to automate payments on local city buses – the cardless transactions being even faster and simpler.

Why
Integrating the different parts of a city's public transport network is more convenient for customers, allowing them to plan journeys better; in particular, improving "last mile" connectivity by including informal public transport encourages greater use of public transport overall. Generating real-time data across the network can enable improvements in operational efficiency and utilization of assets.

How
Ahmedabad's automated payment system uses smart cards to gather users' transit data, which enables automated, cashless transactions and real-time monitoring of the fleet of public transport vehicles, while Yinchuan's facial recognition software links passengers' faces to their bank accounts and collects fares directly from there.

Potential
Offering a seamless experience across mobility systems, and giving both customers and network operators the information they need to improve planning and scheduling, has the potential to decongest public transport, allowing the city to maximize the use of existing transit capacities rather than investing in new urban mobility infrastructure.

Governance

The deluge of data available and the increasing complexity of today's urban issues compel us to develop more open and inclusive models for governance. Governments can play a fundamental role in fostering innovation – from supporting academic research to promoting applications in unglamorous but crucial fields that might be less appealing to private capital, such as municipal waste or water services. They can also promote the use of open platforms and standards in such projects, which would speed up adoption in cities worldwide.

City governments need to establish synergy with the various actors that can make a city smart, such as businesses, research centres, associations and private individuals, including youngsters. They can invest in developing a bottom-up, innovative ecosystem to engage citizens in various ways, for example, supporting accelerators, creating regulatory frameworks that allow innovation to thrive, and involving people in discussions on how open data can be used to improve urban life.

9. Citizens participate in making the city budget

What

Several cities are pioneering methods to engage citizens in planning and budgeting. Melbourne, for example, has twice used “people’s panels” to guide decisions where recommendations included increasing city taxes to fund climate change programmes. Quito’s platform Mi Ciudad, which shares data about the city – including services, infrastructure and budget allocation – is being developed to enable more citizen participation; currently, a percentage of the municipal budget is allocated based on decisions by citizens at neighbourhood assemblies. “Youth Lead the Change” - a participatory budgeting programme in Boston founded in 2013, was the first of its kind in the United States; over 2,000 youth aged 12 to 25 decide together how to spend one million dollars of the city’s capital budget, developing and voting on project ideas and playing a role in their implementation.

Why

When city administrations are making the inevitable trade-offs involved in spending limited budgets, it is challenging for them to truly represent the views of all citizens. Melbourne’s “people’s panels”, in particular, exemplify the use of new technology to engage citizens in prioritizing the relative importance of issues, rather than merely listing issues they think are important.

How

In Melbourne, expressions of interest were sought from members of the community and representative groups of around 24 people were selected and provided with extensive data. Quito’s platform enables citizens to download data and an app is being developed to enable citizens to participate in the budget planning process. Boston’s programme invites public submission of ideas, which youth develop into concrete proposals.

Potential

Participatory budgeting can engage communities to take more interest in the running of their city – in the case of Boston, specifically engaging youth. When city governments are confident that their decisions reflect what citizens actually want, they are more likely to take decisions that are courageous and meaningful.

Useful Links

https://participate.melbourne.vic.gov.au/10yearplan
http://gobiernoabierto.quito.gob.ec/?page_id=1170
https://www.boston.gov/departments/boston-centers-youth-families/youth-lead-change

10. Easy access to all relevant information on planning issues

What

Cities are developing online platforms to make it easier for citizens to find out about planning issues and land use: zoning regulations, local development plans, heritage sites, flood risks, building permits, planning applications and so on. Examples include Myplan.ie, which covers all land in Ireland, and Buildingeye.com, which has been launched in San Francisco, Palo Alto and Pittsburgh.

Why

Ireland's 31 separate planning authorities – including city and county councils, town councils and borough councils – have together adopted over 400 statutory plans, in a variety of formats that make it difficult for citizens and local authorities alike to get an effective overview of factors that could affect their decisions. In the US, Buildingeye.com makes it easier for neighbours and community groups to find out what is happening in their area, reducing the hundreds of phone call inquiries that city workers process every day.

How

The platforms combine data such as street maps, aerial photography, historical maps, architectural heritage, areas of special protection, nature reserves, floodplains, population census and education services. Myplan.ie took five years to develop, in a collaborative approach involving local authorities, government departments and agencies, and independent experts, which incorporated information into Ordnance Survey Ireland's web mapping service. Users of Buildingeye.com can browse a map and click icons representing proposed projects, colour-coded to reflect the planning status and see associated drawings and documents.

Potential

Such platforms can radically improve the efficiency and effectiveness of local authority plan making, enabling the planning service to perform better with fewer resources. For individuals and organizations – such as property developers, architects, surveyors, lawyers and planning consultants – they can lead to significant efficiency gains from no longer having to piece together information from multiple sources.

Useful Links

http://www.myplan.ie
http://www.buildingeye.com

11. World's first public-facing crime forecasting platform

What

CrimeRadar is a free app for citizens in Rio de Janeiro, Brazil, to improve their awareness of crime risks. While many cities are using "predictive policing", data and machine learning can now be used to anticipate the spatial, temporal and demographic risk of crime events at a very high level of resolution; most of such tools are currently proprietary and designed for police and are not made available to citizens. CrimeRadar is the world's first public-facing crime forecasting platform.

Why

Data on crime allows not only trends to be tracked, but predictions to be made about the probability of crime occurring. This can help citizens to distinguish between real and perceived crime risks, and make informed decisions about their daily routines to reduce their risk of being a victim of crime.

How

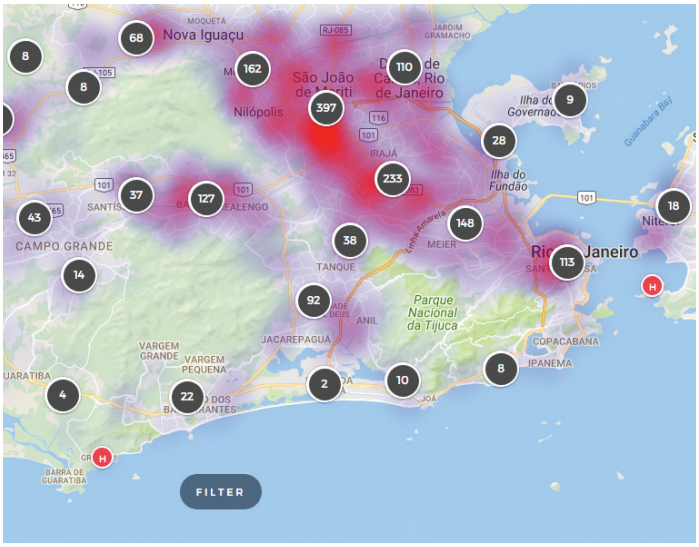
With increasing accuracy, machine learning algorithms can find patterns in data drawn from a range of disciplines – including geography, behavioural economics and even seismology – to create more accurate models of crime dynamics. CrimeRadar has assessed over 14 million crime events between 2010 and 2017 to develop a "score" for crime risks in six-hour blocks for every 250 square meters of metropolitan Rio de Janeiro.

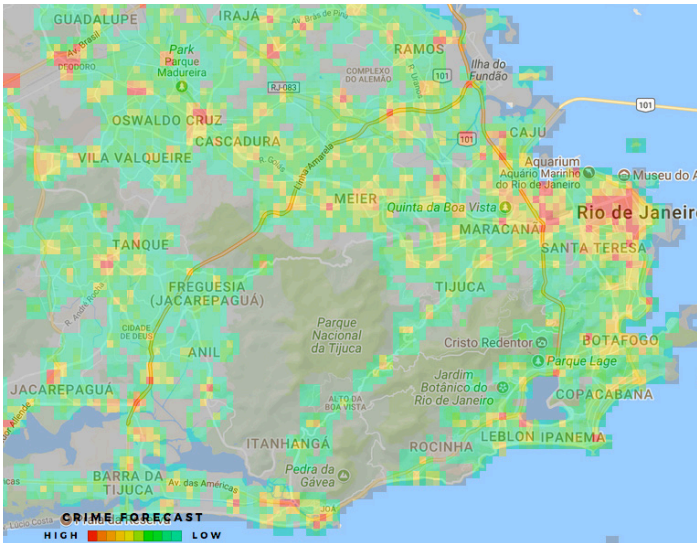
Potential

Tools like CrimeRadar can empower citizens to better understand the risks they face. As an open-source platform of information, CrimeRadar also speaks to the rights of citizens to transparency, including on public security, often a taboo topic.

Useful Links

https://www.weforum.org/agenda/2017/02/what-happens-when-we-can-predict-crimes-before-they-happen





rio.crimeradar.org allows the public to see both its analysis of historical crime data and predictions for where future occurrences are likely to occur

12. GIS tracks unplanned settlements – and empowers their inhabitants

What

Geographic information systems (GIS) are computer systems for mapping and analysing various sources of geographic information, including from aerial photos. Two initiatives in India demonstrate their potential. With the help of a local university, Navi Mumbai municipal corporation is using GIS to track violations of its land use plan and identify infrastructure gaps. In Kolkata, non-profit social enterprise "Addressing The Unaddressed" is providing unique postal addresses to people who live in unplanned settlements such as slums and shanties.

Why

Land use in India is difficult to monitor: municipalities are not aware of the extent of informal settlements making it hard to enforce land planning regulations or keep track of urban expansion so new settlements can be provided with necessary infrastructure. For the people who live in unplanned urban settlements, the lack of an official address creates complications in day-to-day activities such as claiming social welfare entitlements, getting connected to utilities, and accessing schools and healthcare services.

How

Experts from NYU and Spain helped to set up the first GIS master's degree in Mumbai, which led to the creation of the system for tracking urban sprawl. Addressing the Unaddressed assigns a unique, GPS-based "GO Code" to dwellings in unplanned settlements, and collates them in a file on its website; so far they have provided addresses for nearly 16,000 dwellings in nine urban slum areas in Kolkata.

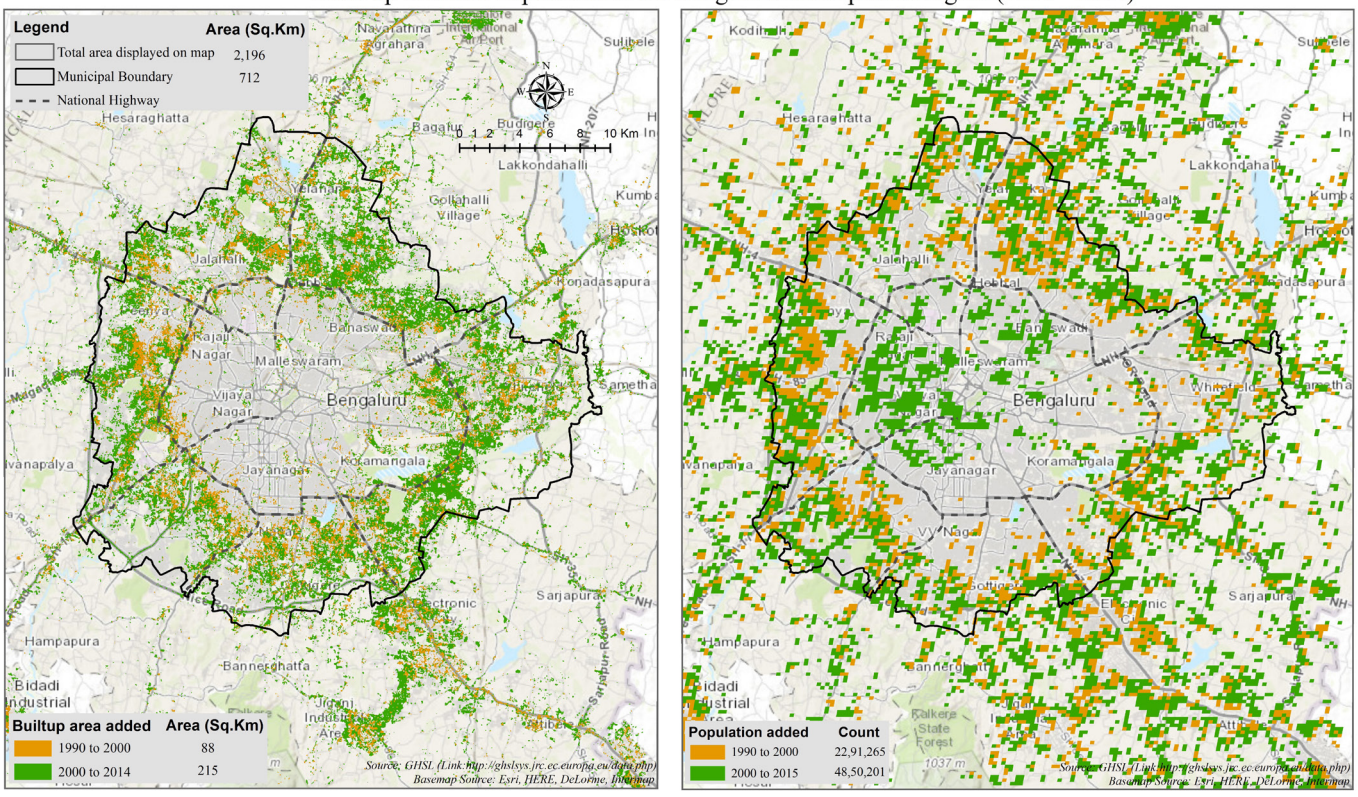
Potential

As many as one in two people could be living in unplanned settlements by 2050. Giving these people an official address will make it easier for them to access services and run businesses. GIS solutions to monitor urban sprawl have the advantage of being easy to scale, as the work can be done remotely.

Useful Links

http://www.addressingtheunaddressed.org/

Built-up area and Population in the Bengaluru Metropolitan region (1990 - 2014)



Comparison of the increase in built up area vs. registered population of Bengaluru metropolitan area between 1990 and 2014"

Infrastructure

Urban population growth is not a new phenomenon. Back in the 1990s, British architect Richard Rogers famously observed that the urban population of the world is increasing at a rate of a quarter of a million people per day – “think of it as a new London every month”. Not only do we need to create new urban fabric to cope with this growth, we also need to make better use of existing infrastructural assets to ensure that our increasingly large metropolises are sustainable.

Smart technologies can help. These “data stories” show how we can apply the Internet of Things paradigm to available resources and old cities, buildings and infrastructure without many engineering obstacles. Historic urban centres that might have struggled to adapt to 20th-century technology – heavy, invasive, and incompatible with a fine-grained city fabric – can more easily adapt to the new, light technology of the digital revolution.

13. Tackling congestion in partnership with taxis and navigation apps

What

Cities are exploring various ways to gather and use data to ease traffic congestion. Boston, for example, has established a data-sharing partnership with the navigation app Waze. HubCab tracks over 170 million taxi trips taken annually in the City of New York to understand taxi users' travel patterns. In Cebu City, the Philippines, the Open Traffic platform optimizes the timings of traffic signals in peak hours using GPS data from the smartphones of drivers for the taxi service Grab.

Why

Congestion has many negative impacts – it increases air pollution and greenhouse gas emissions, and the time wasted by individuals waiting in traffic holds back a city's productivity and economic growth. Effectively addressing congestion requires accurate, real-time data on traffic speed and flow, which resource-constrained transport agencies in many municipal authorities would find it financially and technically challenging to collect via building their own infrastructure. Both parties can benefit from such arrangements: the municipality of Boston uses Waze's data to identify problem such as potholes and hotspots for illegal parking; in return it gives Waze advance notice of planned construction sites, parades and other events likely to disrupt traffic, which enables Waze to improve the service it offers to its users.

How

Leveraging GPS data from taxi drivers' phones, the Open Traffic platform provides a graphical user interface that allows government agencies to easily query and visualize stored, anonymized traffic statistics. In the pilot with Grab, a World Bank team tested how closely Open Traffic's analytical results reflected reality, and found that they successfully, consistently predicted travel times along key corridors. The platform can be used to generate inputs such as travel-time survey data for transportation planning, saving city authorities the cost of fieldwork, encoding and analysis.

Potential

The next generation of congestion management solutions will enable traffic management agencies to make better, evidence-based decisions about traffic signal timings, public transport, road infrastructure, emergency traffic management and travel demand management, as well as helping to develop and optimize trip-sharing services. This will translate into fewer and quicker journeys, lower travel costs and a cleaner, less-polluted environment

Useful Links

http://www.worldbank.org/en/news/feature/2015/10/19/how-an-open-traffic-platform-is-helping-asian-cities-mitigate-congestion-pollution
http://www.hubcab.org/#13.00/40.7219/-73.9484

Hubcab invites users to explore how taxicabs connect New York City

14. Reducing wastewater, improving treatment – and using sewage to power cars

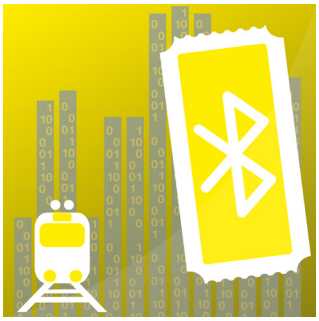
What
Data is improving how cities manage sewage and wastewater. In Quito, Ecuador, citizens are encouraged to use an online calculator to learn about their water footprint and how to reduce it. Copenhagen, Denmark, is forecasting the distribution of rainfall to anticipate where and when its wastewater system will come under most pressure, and take steps to manage the infrastructure accordingly. In Fukuoka, Japan, human sewage is being used to produce hydrogen for fuel in fuel-cell vehicles, which results in 60% less carbon emissions than hydrogen produced by other sources.

Why
These interventions address various problems: in Copenhagen, the risk of extreme rainfall events leading to discharge of untreated sewerage; in Quito, the higher per-capita use of water than in comparable cities such as Bogota and Lima; and in Fukuoka, the need to balance environmental concerns with promoting urban vitality.

How
Copenhagen is leveraging real-time data from local weather radars as well as historical data from the Danish Metrological Office: radar-based rain forecasts and models of the sewerage system's behavior have successfully predicted flow and/or water levels several hours in advance. Quito's app compares a user's water footprint with the average target, and provides tips and recommendations to reduce it. Fukuoka city sewage treatment plants produce hydrogen from the biogas they generate in the treatment process, and supply it through city hydrogen stations to fuel-cell vehicles.

Potential
Each of these interventions could have wider effects: improving efforts to inculcate more sustainable habits of water use; optimizing exploitation of both sewerage systems and wastewater treatment plants; and further reducing carbon emissions through the promise of new technologies, such as using solar or wind power to produces oxygen and hydrogen through water electrolysis.

Useful Links
www.regnradar.dk
http://facts.city.fukuoka.lg.jp/en/data/hydrogen-from-sewage/



15. Telemedicine via tablets helps first responders to reduce unnecessary hospital visits

What
Working with Cisco and Panasonic, the Houston Fire Department developed the Emergency TeleHealth and Navigation solution (ETHAN), a tablet-based app for first responders – firefighters and emergency medical technicians – to increase the efficiency of emergency services. According to a Journal of Telemedicine and Telecare article published in December 2016, Houston fire trucks and ambulances are now back in service approximately 39 minutes after being dispatched, down from 83 minutes.

Why
Emergency medical services across the US are under siege. Houston's fire department receives nearly 600,000 emergency medical calls per year; the city's wait times at the Emergency Department can be as long as 14 hours. Part of the problem is that many 911 calls could be dealt with more efficiently and at lower cost by primary- or urgent-care services. There is a need to reduce unnecessary transports to the emergency department, while still providing quality care.

How
ETHAN helps first responders to triage situations and locate alternative service and transportation options for non-emergency issues: it connects 911 responders, the University of Texas Health Science Center, a nurse line, a network of primary care clinics and a taxi service. A local health information exchange can pull up patient health records, and video consultations with qualified physicians help to determine the most appropriate course of action.

Potential
Additional evaluations of ETHAN's impact are forthcoming, but already Houston estimates it is saving almost a million dollars a year.

16. Improving tourist attractions by tracking how visitors use them

What

A pioneering study has analysed visitors' behaviour in one of the world's largest museums – the Louvre in Paris – using anonymized longitudinal datasets, generated by non-invasive Bluetooth sensors. The study enabled the museum's managers to understand what routes visitors tend to take around the museum and how long they spend in different parts of it.

Why

A city's cultural attractions are important to its residents and tourist trade, and data about visitor behaviour and experience are important in informing how attractions such as museums are managed. This data has traditionally had to be generated by time-consuming observations and surveys.

How

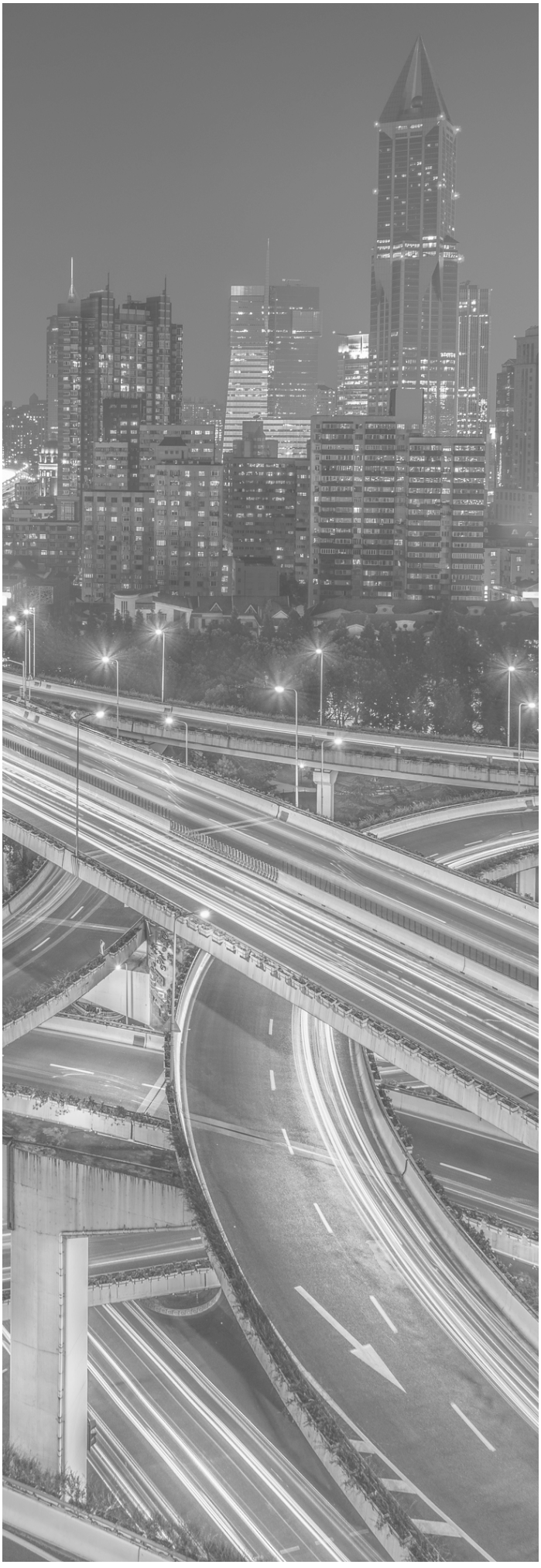
Seven Bluetooth sensors, with sufficient coverage to measure visiting sequences and duration, were deployed in key locations at the Louvre. They recorded a unique, encrypted identifier distinguishing each Bluetooth-enabled mobile device within its range, as well as time stamps for entry and exit. If we assume that a mobile device belongs to a person, it is possible to relate the movement of the device to that of the visitor. The study was conducted over a 24-day period with a high volume of visitor traffic.

Potential

From such studies, managers of cultural attractions can simulate and predict valuable information such as crowd density and local congestion, enabling them to improve how well their attractions serve their cities.

Useful Links

http://senseable.mit.edu/louvre



Environment

The importance of cities for the environment can be summed up with four numbers: 2, 50, 75 and 80. Cities occupy 2% of the world's surface; more than 50% of the world population lives in them; they consume 75% of global energy supply; and are responsible for 80% of carbon dioxide emissions. By making cities just a little more sustainable – more green, able to consume less energy or natural resources – we can have a major positive impact on the planet, as these data stories show.

Elisée Reclus, the 19th-century French anarchic geographer, once wrote: "People must have the dual possibility of gaining access to the delights of the city, with its solidarity of thought and interest, its opportunities for study and art education, and, at the same time, the freedom that is nourished by nature and is realized through the varieties of its open horizons." Today's digitally augmented cities could change our relationship with nature by getting closer to realizing this vision.

17. Designing with sustainability in mind

What
A new annual publication series helps aggregate the energy and water use data for architecture and planning firm Gensler's global project portfolio. Through increasing global data transparency, total CO_2 savings have increased by more than 60%, from 4 million metric tons to 11 million metric tons in two years. Statistical models predicting energy and water savings are created from aggregated building performance data, and these models are analysed to demonstrate the impact of local codes, market forces, independent green building rating systems, and other sustainability incentives as it relates to climate change mitigation and adaptation.

Why
The built environment is the single biggest source of global energy consumption, and buildings are responsible for at least one-third of global greenhouse gas emissions. This sector will need to become more sustainable to meet the goals laid out in the UN's Paris climate change agreement. To accomplish this, governments, businesses and institutional actors need more data on the policies and market incentives that are having the greatest sustainable impact.

How
The "energy use intensity" and "lighting power density" averages are compared to baselines established by the American Institute of Architects 2030 commitment, while water savings are compared to efficiency averages published by the U.S. Environmental Protetcion Agency. Using these baselines, aggregated performance metrics are compared as year-over-year trends, and local codes and market incentives are analyzed through geographic and industry comparisons.

Potential
This initiative focuses on identifying sustainability benchmarks that are having the greatest energy and water savings impact. By comparing market trends with local codes, architects are identifying cost effective benchmarks aimed at helping business leaders and policy-makers achieve ambitious sustainability goals in the built environment.

18. Engaging citizens to map urban trees – and advocate for more

What
Treepedia will allow city dwellers to view the location and size of trees within their communities and to submit input to tag, track and advocate for more trees in their cities. It is designed to teach urbanites a greater appreciation of the green spaces around them and reinforce the role of the green canopy in responding to climate change.

Why
The green canopy is an important part of urban life. Trees help mitigate extreme temperatures, provide a natural respite from traffic, noise and congestion, and improve the quality of life for those living in urban environments. However, the average citizen is often removed from understanding the individual features of their unique environmental habitats. If citizens are better engaged, they can play a more active role in campaigning on behalf of the landscapes they dwell in.

How
Treepedia utilizes Google Street View panoramas to create a Green View Index, which enables scientists and city dwellers to monitor urban tree coverage and take action to improve it. The addition of a crowdsourcing and citizen-interactive platform will enable citizens to add information on the location of trees. MIT Senseable City Lab developed Treepedia in partnership with the World Economic Forum's Global Future Council on Cities and Urbanization and its Global Shapers Community.

Potential
The project has the potential to be scaled to additional cities where Google Imagery is available, and utilize satellite data where it is not. Ultimately, by inspiring citizens to seek the planting of more trees in their cities, it can help address liveability and mitigate climate change.

Useful Links
http://senseable.mit.edu/treepedia
melbourneurbanforestvisual.com.au

19. Dynamic signs and intelligent street lights make cyclists' lives easier

What
Copenhagen is using data and Fourth Industrial Revolution technologies to make it easier to cycle the city. Dynamic bicycle signage and a mobile app give cyclists real-time traffic information about the most efficient route to take: along busy cycle tracks, screens display information on suggested alternative routes with less congestion or less exposure to snow or wind. They also display riders' current speed and whether they should slow down or speed up to ride the "green wave" of synchronized upcoming traffic signals, another part of the project. For night-time cycling, Copenhagen is introducing smart street lights that turn themselves off when the street is empty but shine brightly when an oncoming cyclist is detected.

Why
In Copenhagen, cycling currently accounts for 41% of the modal share. The city would like to increase this to 50% by making it more attractive to cycle, addressing some of the challenges of accessibility and security. A third of all traffic accidents occur after the hours of darkness, despite there being much less traffic at night, with cyclists and pedestrians comprising two-thirds of those who are killed or seriously injured.

How
The signage and app were developed based on interviews with cyclists and testing a prototype; this showed cyclists prefer to run a small detour if it means less congestion or a prettier route. The smart street lamps were tested at a busy intersection, and it was found that extra-bright lights on cyclists approaching a green light made motorists give them extra attention, power was saved by not having light at full power all night.

Potential
Dynamic signage and the "green wave" could be introduced in cities around the world to make cycling more attractive and efficient, enticing people away from other, more polluting forms of transport. Together with intelligent street lighting, this could offer significant savings on energy and emission. The project is considered also a vital step in Copenhagen's aim of being carbon-neutral by 2025.

Useful Links
https://bicycledutch.wordpress.com/2014/10/09/dynamic-sign-to-indicate-the-fastest-cycle-route/

20. Data helps cities to prepare for natural disasters – and respond

What
Data scientists are looking at how to empower urban decision-makers to prepare for, respond to and recover from natural disasters. 1concern is a platform of cutting-edge tools that create situational awareness, highlight realistic hazard scenarios and build resilience by combining human experience and artificial intelligence. The city of Quito has introduced "Quito Listo" to build a culture of prevention, awareness of risks and tips about best practices, with risks georeferenced to neighbourhood level.

Why
Due to its geography, Quito is highly exposed to different kinds of natural risks, such as volcanoes, earthquakes, floods, fire and mud slides. But all cities are vulnerable to some extent. 1concern was set up by Stanford engineer Ahmad Wani after surviving a traumatic flood in Kashmir, India, in collaboration with computer scientist Nicole Hu and earthquake expert Tim Frank: it began as a research project, and grew into a mission to revolutionize emergency operation centres as they recognized the need.

How
1concern's core product is "seismic concern", which provides alerts when an earthquake occurs, displaying a colour-coded map of likely structural damage and highlighting particular insights like a block with a high proportion of elderly population, or the number of kids in an affected school. If a natural disaster hits on a weekday, schools and offices can be marked top priority, whereas on a weekend, resources can be deployed elsewhere first. It also offers a training module, creating simulations based on the same artificial intelligence, stochastic modelling and geophysical and seismological research. Quito Listo produces data that allows different municipal offices and NGOs to coordinate in real time.

Potential
1concern and Quito Listo point towards a potential future in which data helps jurisdictions to build more resilient cities that are better prepared for all natural disasters.

Useful Links
http://www.quitolisto.gob.ec/
http://www.oneconcern.com/

Conclusion

The 20 global data stories presented in this report show ways in which vast quantities of data can improve the quality of urban life. While selected because of their anecdotal value, they also suggest the range of opportunities that could open up when people use their imagination to leverage the Fourth Industrial Revolution's capacity to produce information.

Many of these stories have a moral. To scale up the opportunities they describe, it is crucial that an increasing number of people have access to data and participate in a collective discussion on its use. Big data should become, as much as possible, open data to have a profound impact on cities.

If this path can be followed, city dwellers worldwide will invent more and more compelling data stories – they could multiply alongside data itself, with the 20 compelling stories in this report expanding perhaps to 200, 2,000, 20,000 or more.

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