Open Data as a Catalyst for the Smart City as a Local Innovation Platform (*)

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Abstract: This article aims to better frame the role of open data in the divergent operationalisations and interpretations of the smart city concept. We start by exploring top-down approaches to the smart city, followed by what purely bottom-up initiatives can look like. A clear overview of stakeholders' different viewpoints on the city of tomorrow is provided, particularly the consequences and potential impacts of these differing interpretations and approaches which should be of specific interest to researchers, policy makers, city administrations, private actors and anyone involved and concerned with life in cities. The approach of looking at the smart city as a local innovation platform is presented and we see the very specific role that open data initiatives can play in this context. The reuse of (specifically) public sector information and creating a surrounding ecosystem of public and private actors will be key in tackling future urban challenges and achieving smart city goals.
Key words: open data, smart cities, open innovation, platforms.

Today, urban centres are the heart of the global economy, generating 70% of global GDP (see e.g. DE LA PEÑA, 2013) and home to more than 50% of the world's population, growing to 70% by 2050 (see UN Department of Economic and Social Affairs, 2008). This relatively new imbalance between rural and urban population poses many and diverse challenges for cities, their governments and citizens. A prerequisite to accommodate this scale of urbanization is without any doubt well-functioning infrastructure for urban areas, ensuring efficient and effective urban processes (NAPHADE *et al*., 2011). As a consequence, investments into urban infrastructure are likely to continue and grow (United Nations Human Settlements Programme, 2012). An accepted idea in this regard is to incorporate modern technology into the urban context. As more

citizens (or consumers, depending on the point of view) move to urban areas, actors from the ICT industry become increasingly interested in offering services that are tailored to life in the urban environment. Cities and local governments are at the same time exploring the role that new ICT services and products can play in increasing the quality of life of their citizens or optimizing internal processes. In recent years, this quest is often captured in the "smart city" concept (TOWNSEND, 2013). It originates at the crossroad of technological progress and the realization that urbanization, up until today, cannot accommodate the expected demographic and environmental circumstances of the future. The smart city concept has become key in bridging academic research, projects and commercial initiatives exploring the role of technology in urban life (WASHBURN *et al.*, 2010).

At the same time and often in the framework of this broader dynamic, open data is becoming an increasingly relevant concept. The idea is that local governments are "sitting" on a wealth of information related to divergent aspects of life in the city, but this data is either not publicly available or not easily interpretable. This has sparked a movement to encourage the opening of datasets, under the open data moniker, which is gaining traction across local and national governments throughout the world (OKFN, 2012). It is accepted that open data will be increasingly important in stimulating the development of new, innovative services and increase efficiency when it comes to the (local) government's role in this (VICKERY, 2011). The goal of this article then is to frame how open data can play a role as the concept of the smart city shifts from a completely top-down or bottom-up approach to one of collaboration, context and the collective. We do this by assembling an eclectic overview, bringing together definitions, examples and operationalisations from academia, policy and industry as well as identifying major trends. The first two visions on the smart city are presented, to then proceed to the development of a local innovation platform take on the city in which open data is a key catalyst to creating new public and commercial value.

■ Top-down

The first approach assessed here adheres to top-down dynamics, often closely related to the technologically deterministic idea of a "control room" for the city (HALL, 2000). It aims at providing an ICT-based architecture to

overview urban activities as well as the tools to (automatically) interact with infrastructures, gather vast amounts of data and adjust parameters to predefined optima (IBM, 2009). This approach places strong emphasis on optimization through technology (see also CAMPKIN & ROSS, 2013).

Providing the systems that are capable of working with these vast data sets, referred to under the moniker of "big data", then becomes an interesting business. This way of making cities smarter promises enormous opportunities for large private companies, such as technology vendors, network companies and software industry players. In its most extreme manifestation, a top-down approach translates to cities that are planned, designed and built from scratch with the optimization of urban processes through technology in mind. The examples of Songdo and Masdar can be seen as the pinnacle of this particular vision of the smart city. But both have been heavily criticized for being sterile, overly planned, prohibitively expensive, anonymous, uniform and conformist (SENNET, 2013; TOWNSEND, 2013) and the result is that these cities struggle to be completed within the predicted budgets and timeframes and/or do not attract enough economic activity (and thus jobs) so that people want to move there.

Of course in most cases, technology will need to be integrated into existing urban infrastructure. There are large potential benefits tied to having an integrated smart city solution in a city: many different services and infrastructure systems can be managed from one central hub, keeping oversight on many divergent aspects of life in the city. The focus on integrated infrastructure and technology is reflected in the following description of what the smart city is: [A city] "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city" (HARRISON *et al.*, 2010). The Brazilian city of Rio de Janeiro was amongst the first to implement the integrated smart city solution developed by IBM; the 'Intelligent Operations Centre'. This solution combines feeds from over 560 cameras and can display over 60 layers of data, gathered from sensors across the city on a map (SOFFEL, 2013).

The huge economic potential is – at least to the same degree as its potential for improving the urban area – the main driving force behind this approach. Many major IT companies and municipalities around the world are looking for their slice of the smart city pie. Market researchers and consultants of PikeResearch have predicted that global investment in smart city technology infrastructure will reach $108 billion by 2020 (Pike Research, 2011).

IBM and Cisco, among others have already established themselves as prominent players in the field. They are among those large technology vendors, which have realised the potential of the smart city and are actively seeking out and soliciting local governments to invest in their respective technologies. While these companies are competing, they also appear to be specializing in specific aspects of the smart city, as aptly put by Townsend (2013: p.63):

> "If Siemens and Cisco aim to be the electrician and plumber for the smart city, IBM's ambition is to be their choreographer, superintendent and oracle rolled into one".

Discussion

Certain kinds of top-down visions have been heavily criticized with the main argument that they are dictated by commercial interests, and that they entail questions of control and privacy. The "control room" smart city approach, which aims at monitoring all aspects of urban life might soon result in an ubiquity of data collection, presenting a "set of potentials disturbingly consonant with the exercise of authoritarianism" (GREENFIELD, 2012, para. 31). Too much monitoring and too many integrated technologies and infrastructures can pose actual threats for freedom and privacy, whether controlled by private actors or ruling bodies.

However, the shortcomings of a top-down smart city might go further. What has also been referred to as a "city-building industry" (JOROFF, 2008) might not only hamper the innovation potential inherent to cities, but in some cases even have detrimental effects:

> "More damningly still, the big technology companies are selling 'smart city in a box' solutions to cities, walled gardens that prevent scalable local business innovation." (HEMMENT & TOWNSEND, 2013, p. 8)

The approach to the smart city these companies take essentially revolves around efficiency: algorithms, measurements, optimization and so on. This gives rise to the question of what is being measured – and more importantly, what is not – as well as who has access to the measurements, who is being excluded and at what cost? In Rio for example, open hospital beds and enrolments in schools are not monitored by the integrated smart city system (DE LA PEÑA, 2013).

The approach to the smart city, as assessed above, then becomes an ambiguous one. On the one hand, top technology vendors have resources and knowledge at their disposal, on which the public sector needs to rely while facing urban challenges. Furthermore, the business potential in this context is too high for companies with ambitious commercial targets to resist. On the other hand, cities are about citizens, about the people who live and use them; in terms of for whom they are built, but also in regards of the potential for innovation and finding appropriate solutions. Therefore, this top-down vision is contrasted by the opposite: a purely bottom-up view on the smart city, which is outlined in what follows.

■ Bottom-up

Infrastructural or top-down viewpoints are juxtaposed against a more experimental, bottom-up understanding of what a smart city could be. In this perspective, change and improvement comes from the people "using" the city. It dismisses any form of top-down urbanization, in particular with the involvement of powerful private companies. The bottom-up smart city is, foremost, about the "Smart Citizen" (HEMMENT & TOWNSEND, 2013; VANOLO, 2013): those who live, work, and engage in all kind of activities in the city. Rather than working towards centralization, such a view on the smart city takes a decidedly distributed approach, supporting and accepting some form of chaos (LINDSAY, 2011).

These characteristics often conflict objectives of decision-makers, urban-planners, and dynamics of the globalized economy. Chaotic bottom-up processes oppose the idea of a master plan, an "ideal" state of place. Since the city is a system of systems put together by people who bring it to life, it is complex and cannot be but dynamic and flexible. Consequently, the solution to urban challenges of the future, a real smart city, is more than just technological, networked and intelligent: it is about people. DE LA PEÑA (2013) compares this complexity of the city with the "non-hierarchical complexity" of the internet: as the internet is open and participatory, an smart city should actively and consciously enable and encourage citizens to shape their own urban experience.

Examples of these purely bottom-up approaches can be found in citizen initiatives (CHOURABI *et al*., 2012) and even (semi)-illegal interventions in the public space, such as so-called guerrilla bike lanes where citizens,

unhappy with local biking infrastructure, paint bike lanes on the street without authorization (MUÑOS, 2013). These types of initiatives are also referred to as tactical urbanism (HAMDI, 2004). Tactical urbanism tends to consist of "small scale interventions [that] are characterized by their community-focus and realistic goals" (BERG, 2012) and are often short-term or temporary, cheap and aimed at increasing quality of life in a certain way or addressing a specific neighbourhood concern. In this perspective, what defines the smart city is not the infrastructures or networks it offers, but the ways in which its citizens interact with these systems as well as each other.

Discussion

Whereas the idea of a master plan, an ideal, measurable and controllable state often delivers deficient outcomes, relying solely on bottom-up processes also appears unlikely or even infeasible. Citizens are not detached from the wider urban context they live in, with other stakeholders playing – in some cases powerful – roles. Although the examples listed above can be appealing or charming and have in some cases impact and effect some change, they lack a holistic vision on the issue at hand, are often (very) short term, can conflict with some long term goals set out by local policy and in some cases even be illegal. Some authors argue for a "Smart Citizen" (HEMMENT & TOWNSEND, 2013; VANOLO, 2013) that uses a variety of tools to interact with and move around the city, and for whom the emphasis lies on his/her citizenship, rather than technology as a primary factor (TOWNSEND, 2013). However, relying purely on bottom-up initiatives remains problematic with regards to scalability, interoperability, barriers and incentives to entry. The city of the future then cannot place all responsibility for its succes with its citizens.

■ The smart city as a local innovation platform

While both views and approaches to the smart city have their merits, we have also illustrated that they each exhibit substantial problems:

> "Change seldom arises from purely top-down or bottom-up systems and processes." (SHEPARD & SIMETI, 2013)

Therefore, a more nuanced interpretation is proposed, one that combines top-down and bottom-up approaches, and establishes the smart city as a

platform that fosters the collective (local) intelligence of all affected stakeholders. After all, cities essentially constitute shared responsibility and resources (CAMPKIN & ROSS, 2013) and can be seen as a system of systems (FISTOLA & LA ROCCA, 2013). This means looking at the smart city as a meeting place where the public sector, private interest and citizens can come together to generate new value, to collaborate and innovate together (BAROROSO & FEIJOO, 2010; VANOLO, 2013). Smart cities can only be successful if they act as local innovation platforms that bring together all involved stakeholders. Still, "no one has so far found a way to intelligently bring together the big technology platforms offered by global corporations, with local technology projects and the interests of citizens" (SHEPARD & SIMETI, 2013, p. 10). O'REILLY (2011) embraces such an approach and conceptualizes them, describing how technology can play a role in bridging interests of the public sector, private interests and citizens; he introduces the ideas of "government as a platform" and "government 2.0". The latter refers to "the use of technology – especially the collaborative technologies at the heart of Web 2.0 – to better solve collective problems at a city, state, national, and international level." Viewing the city as a platform in this light means that it acts, like the Web, primarily as an intelligent broker, connecting the edges to each other and harnessing the power of the users themselves (see O'REILLY, 2005). The platform is the intermediary, the enabler of interaction and collaboration of multiple actors who have corresponding interests or needs. The delivery of public services in such a reciprocal relationship between all stakeholders is promising.

Open innovation, co-design & living labs

For our platform approach to the smart city, the concept of open innovation (CHESBROUGH, 2003) can also be of particular relevance. It relates to 'public-private-people partnerships', i.e. organized collaboration between all involved stakeholders (governments, businesses, users/citizens, etc.). It includes co-creation of services and products, and the availability of open platforms that facilitate the necessary collaborative processes and interaction (DG Communications Networks, Content and Technology, 2013, p. 56). Co-design and co-production approaches emphasize engagement by those responsible for delivery of a service or product with stakeholders in general, and with the end user/customer/citizen in particular (Smart Cities Project, 2011, p. 6). The aim is to establish processes that allow all players to make constructive contributions according to their own role and knowledge without a stakeholder or interest being more important than

another. Open innovation is already being practiced, in the form of Living Lab projects that muster the stakeholders required to make an innovative initiative successful (SCHUURMAN *et al*., 2012). Living labs can provide the platforms for open innovation, which facilitate productive collaboration and thereby ensure that development complies with real problems and needs.

Discussion

We have illustrated that a purely bottom-up or top-down view on the smart city will struggle to be effective and future-proof, and therefore suggest looking at the city as a platform. But also local innovation platforms are not without their potential difficulties. First of all, organizing such an intense collaboration as required by this approach is not easy. And when it is set up, the collaboration could still run into issues of various natures: diverging visions, operational issues, financial inhibitors and so on. It is therefore important to consider who ~~organises~~ organizes and facilitates the collaboration and under which conditions partnerships come to be. When considering this as a technological platform, questions surrounding platform leadership or even competition among platforms could also be raised (GAWER & HENDERSON, 2007).

Alongside organizational difficulties, valorisation can be an issue of local innovation platforms as well. This relates back to the scalability question, often present in an EU context, and should increasingly be a point of concern for open innovation and related initiatives. How one transcends the project context and can move a concept or idea into a real application or service that adds value to citizens is one of the major challenges.
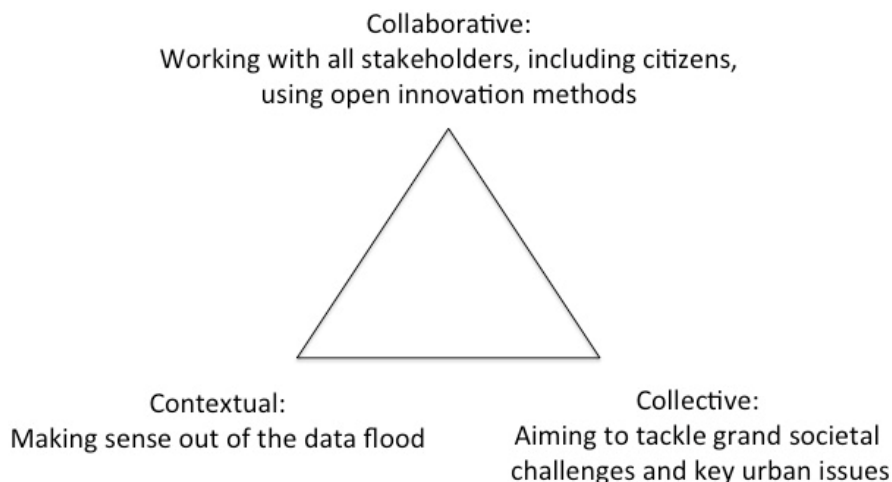
A final point of attention for smart city projects should be the digital divide and exclusion (GRAHAM, 2002). Around the world, digital services in many different forms are becoming consolidated as an integral part of daily life. As these services become more integrated into our daily (urban) context, we need to be aware of people that are excluded from these services, or do not have the access or skills to use them in a proper way. Education, in combination with the offering of alternative ways of getting access to public service, needs to be top of ~~mind~~a priority with involved local policy makers in ensuring that no one is excluded from access and the required skill set to participate. Only then, can any approach be ~~can~~ honestly be called smart.

Smart city operationalization

In spite of the many attempts at definitions and approaches, the smart city concept remains elusive. However, it is an indication of the increasing need to develop new ways of looking at the city of the future and to think about structured approaches to provide answers for the diverse and complex questions companies, citizens and governments face there. Rather than attempting a holistic and general definition of what a smart city is we will clarify our perspective on the concept after having assembled this overview. It should be clear we consider cases that are linked to the urban space and the interactions between the physical and the virtual, which are mediated by ICTs (be they social media, innovative wireless networks, mobile devices, cloud technology, etc.) or developed using innovative methods (such as co-creation, living labs research, PPP business models, etc.), and that involve or engage citizens in innovative experiences with the goal of increasing their quality of life in meaningful ways. Smart cities then, should capture and foster creative and collaborative innovation through (direct) interactions between public bodies, private actors and citizens in:
- dealing with the next data flood (emerging from linked open data, big data, the internet of things, sensor data etc.);
- identifying and tackling new relational complexities between actors;
- facing grand societal challenges in a local context (e.g. green mobility, security, new forms of local and participatory governance etc.);
- while offering innovative and engaging experiences to citizens.

Figure 1 - Three characteristics of a smart city

Collaborative:
Working with all stakeholders, including citizens,
using open innovation methods

Contextual:
Making sense out of the data flood

Collective:
Aiming to tackle grand societal
challenges and key urban issues

Collaboration between the public sector, private actors and citizens, and all those players amongst themselves, is the key to making cities smarter (SCHUURMAN *et al*., 2012). The interaction of the three concepts below can be seen as the constituting characteristics of a forward thinking, "smart" city that is serious about local innovation. Such a place should be collaborative, collective and contextual.

Keeping these concepts in mind, it has been shown that open data can be an important catalyst, a first step or even a showcase, in approaching the role of the local government as that of an innovation platform. In any open data project, stimulating collaboration between all relevant stakeholders is proving to be key and open data has the potential to connect local government with divergent outside actors (O'REILLY, 2011), while tackling some important urban challenges. While a purely top-down or bottom-up approach in the same vein as in the smart city domain could certainly be envisaged for open data intiatives as well, lessons from around the world are beginning to prove that only collaborative approaches are producing some any results. The next section will explore how open data can be an ideal catalyst in this context.

■ Open data

Accepting the above and that city governments need to take up the role of a local innovation platform in order to play a relevant and impacting role in the development towards a smart city, how can they achieve this? The following will show that opening up public data for reuse can be a starting point and can be seen as a connector, bringing together local, regional, national or supranational governments on the one hand and other stakeholders such as industry, private actors, academia, incubators, civil society and citizens on the other. The prevailing definition of open data (OD) states that, "a piece of data or content is open if anyone is free to use, reuse, and redistribute it – subject only, at most, to the requirement to attribute and/or share-alike" (OKFN, 2012). Leading arguments broadly claim that opening up data to the public is good for society in terms of democracy, transparency, efficiency and other aspects along that line. It is obvious that in order to have any impact and to create any kind of value, respective data must not only be open, but accessible and usable (see e.g. GOLDSTEIN & DYSON, 2013, p. xi). Less clear however, is not only what the most appropriate ways are to open up datasets, but especially in what

manner accessibility and (re)usability can be achieved and how open data can be valorised.

Valorising a "public good"

JANSSEN *et al*. (2012) state that open data can be defined "as non-privacy-restricted and non-confidential data which is produced with public money and is made available without any restrictions on its usage or distribution" (*ibid*, 2012, p. 259). But in principal, any dataset can be(come) open. Private companies, for instance, could benefit from publishing some of their data, as WOOD *et al*. claimed in *Linking Enterprise Data* (2010). Nonetheless, most significant for the current debate is indeed what should be termed Open Government Data (OGD), "produced or commissioned by government or government controlled entities" (GOEDERTIER, 2013, p. 10): statistics, information about public-service-delivery, science, transport, geography, environment, weather, culture, finances, etc. (OKFN, 2012). Open Government Data or open Public Sector Information (PSI) can constitute an indispensible resource for public service delivery and policy development, but it can also be valuable for others.

As governments and subordinated organisations already possess substantial amounts of data collected as part of their function, costs to open up can be relatively low (DG Communications Networks, Content and Technology, 2013). Thus, such entities clearly constitute a decisive role for open data, not least in terms of the financing of respective projects. Researchers found that, indeed, today "the prevalent (open data) business model [...] is the one where investment and maintenance costs are covered through on-going public funding" (GOEDERTIER, 2013, p. 6). Government resources are limited though, both financially and in terms of expertise. In this regard, O'REILLy (2011) calls for a government as a platform that enables outside actors to provide solutions. Through open data, combining public and private efforts now seems to become possible.

Prima facie, the nature of open data (i.e. free by definition) somewhat conflicts direct commercial revenue generation and it exhibits characteristics of a public good: open data is non-excludable and non-rivalrous, in that nobody should be excluded from its use (for example through pricing), and that use by somebody does not reduce availability to others. In other words, access to the data must not represent a source of competitive advantage as such (FERRO & OSELLA, 2013, p. 2). Additionally, the diversity of involved

actors, interests, and objectives might render such processes very complex (WALRAVENS, 2012).

Value creation by means of open data is however feasible, and in manifold ways. In fact, the economic potential of Open Government Data has been one of the key drivers in corresponding EU initiatives (DAVIES, PERINI & ALONSO, 2013, p. 19). Especially innovation that may stem from OD, caused Neelie Kroes to call OD a "goldmine for unrealised economic potential" and state "the Commission has launched an OD Strategy for Europe, which is expected to deliver a €40 billion boost to the EU's economy each year" (European Commission, 2011). Such an enthusiastic projection can be questioned when the real value and impact of OD remain hard to measure (VICKERY, 2011). However today, we are gradually beginning to see some results of open data initiatives, some of which will be illustrated further on.

Real-life examples of the city taking up a platform role in an attempt to valorise their data can be found in the growing trend of "hackathons", enabling and stimulating developers to create applications based on cities' databases. Cities attempting to leverage their datasets can employ different strategies, of which the most popular seems to be organizing an "Apps for X" event in which developers get access to public data and can win prize money for the best applications or ideas. As these events are increasingly organized around the world, more questions are raised about the sustainability of the apps and ideas that come out of them (KITCHIN, 2013). While this can be a relatively cheap way of promoting open city datasets and can lead to creative and innovative ideas (also in the context of the operationalisations of the smart city above), actually valorising the results of hackathons or transforming them into sustainable businesses or spin-offs has proven far more difficult (KITCHIN, 2013). Local organisers of these events will increasingly need to focus on "what happens after the hackathon" and see whether the city or e.g. a local incubator can play a role. This will remain a challenge for cities in the short term, but is an area where their role as a local innovation platform could really come to the foreground.

Open data business models?

The generation of economic value based on open data is far from straightforward and objectives of OD initiatives need to reach beyond purely commercial considerations; establishing ecosystems, where economic value

arises next to other types of value, needs to be prioritised (GOLDSTEIN & DYSON, 2013). Despite OD being free by nature, business models that generate economic value and still serve the public in benefitting ways need to be constructed. The central question for establishing such sustainable models must be how the positive potential of open data can be fostered, harnessed, and not diminished by an ecosystem of heterogeneous actors that all need to benefit in their own way; and how such an ecosystem can be configured. It is key here that simply publishing data does not automatically create value.

FERRO & OSELLA (2013) present a useful framework to identify roles of commercial actors creating value around OD. On the one hand, enablers facilitate use of data (e.g. though retrieval, storage, categorisation, exposure) "behind the scenes". Re-users, "on the front line", on the other hand, they utilise the data as part of their value-proposition. Latter The latter can again be split into those for whom OD is a key business element, and those that utilise it merely as a complementary instrument.

One example of an enabler of open (government) data is Socrata [1], a US company that offers an advanced open-data platform that includes immediate visualisationvisualization. Their solution is highly successful in the US and Socrata is extending its customer base to Europe, where public organizations increasingly buy in to the company's platform. Examples of successful "OD front line" actors (or re-users) are also around; Stat.io [2], for instance, is a start-up that freely offers open socio-economic data in a highly accessible manner (map-based) and extends services for those who are willing to pay subscription fees. Mapbox [3] offers highly customizable maps, which are used by Foursquare and other popular services. The service is mainly based on OD from OpenStreetMaps and NASA, but combines it with proprietary sources. These are illustrations of how business models can be entwined with OD: the result is higher accessibility and usability of the data, but also economic value creation. It should be noted that whenever public bodies decide to outsource any tasks, related to open data or not, they need to be careful in public procurement procedures to ensure that the openness of the data or its reuse potential is never threatened by any commercial interest. Clear contracts and unequivocal choices for openness and transparency are key in this regard.

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[1] http://www.socrata.com/

[2] http://www.stat.io/

[3] https://www.mapbox.com/

Growing return of open data initiatives

Gradually, the results of various open data projects are becoming measurable a few years after the consolidation of the concept and opening up the first data sets. A notable example is Transport for London, the city's public transport agency, which after some initial resistance is now backing an open data strategy. Since the project started, around 500 different mobile, web and other apps have been created that make use of the real-time data provided by the company. Around 5000 people are indirectly employed as a result of opening up and so the return for the city and citizens is high (STOTT, 2014). The transport agency evaluated the open data project in the same way it does all its transport projects, using the same economic and social indicators (including for example time won saved by commuters because of increased information provision). Where typical projects expect a return on investment of 1.4:1 (for each pound invested, at least £1.4 should come out), the open data project saw a return on investment of no less than 58:1 (STOTT, 2014). Perhaps most telling of all, since the launch of the open data portal and the resulting success, Transport for London does not make its own public transport applications anymore. This example shows one way in which the city or local administrations can play a platform role, providing the framework wherein new ideas, services, and both public and economic value are generated.

Discussion: open data as a catalyst for local innovation platforms

The examples from the two preceding sections illustrate that it is possible for (initially publicly funded) open data initiatives to generate societal and economic value in innovative ways. This however only appears to occur when governments (be they local, regional, national or supranational) explicitly back the open data approach and can play the platform role, bridging public and private interest. When linking this back to the operationalization of the smart city as a local innovation platform, presented above (as being collaborative, contextual and collective), it is clear how open data can be a central component in this context. We have shown that a successful open data based initiative needs to be collaborative: including all relevant stakeholders from the public sphere, private sector, academia and civil society. This is also part of what constitutes a smart city approach in the presented operationalization. The same goes for the contextual aspect of future-proof cities and dealing with the current and imminent data deluge (e.g. generated by the internet of things). Opening up existing datasets and

stimulating the accessibility and (re)use of that data should lead to a better understanding of the context the (local) government and surrounding actors are operating in. Linked open data could be of a particular interest in this regard since it allows for new insights into the urban context. The third pillar of our smart city operationalization is the collective and tackling key urban, societal challenges. Open data can clearly also play a catalysing catalyzing role in this respect, since it often relates to typical urban interest areas such as mobility, sustainability or access to public services. Although the societal and economic impact is only beginning to appear (when measurable at all), it was shown that for local governments that want to develop their role as a smart city and local innovation platform, opening up data in a collaborative, contextual and collective way is an – perhaps most importantly – an achievable first step and potential catalyst for new value creation.

This section also allows us to briefly pause on the recent focus on open (linked)(big) data and the way it is sometimes perceived as offering a more accurate representation of reality than we have ever had access to (see above). We would like to emphasizse here that working with large data sets should always be done in a critical manner as issues related to accuracy, interpretation, representation, ethics, digital divide and so on certainly remain (BOYD & CRAWFORD, 2012). These potentially large issues need to remain top-of-mind with any of the stakeholders working with data, and the (public) bodies opening it up need to always consider the public's interest.

◼ Conclusions and outlook

This article started with a bird's eye view on the state of smart city innovation and the different approaches currently in play. Two contrasting trends each present potential difficulties: a purely top-down view on the smart city carries a danger of authoritarianism with it, while a bottom-up-only approach leans towards chaos and lack of long-term vision. Rather than trying to find the perfect definition for what the smart city is or should be, looking closely looking at who is making claims about the smart city, with which motivations and consequences, is at least equally important. Approaching the concept using the three characteristics presented above is one way of trying to keep this holistic perspective.

Although not without difficulties either, but with more apparent chances of success, it is proposed to approach the smart city as a local innovation platform that bridges different viewpoints and interests. Looking at the smart city as contextual, collective and collaborative, we quickly arrive at opening data as a useful and feasible first step to take. This has proven to be a learning experience that can yield valuable lessons and value for local governments and their entire surrounding ecosystem. However, merely opening up is only the beginning; in order to create value, stimulate innovation and truly play an enabling, open innovation platform role, making the data accessible and (re)usable, while paying attention to the sensitive relationship between public and private, is where the true challenge for local governments lies today.

References

BARROSO, J. L. & FEIJOO, C. (2010): "A Conceptual Framework for Public-Private Interplay in the Telecommunications Sector", *Telecommunications Policy*, 9 (34), pp. 487-495.

BERG, N. (2012): *The Official Guide to Tactical Urbanism*, The Atlantic Cities. http://www.theatlanticcities.com/neighborhoods/2012/03/guide-tactical-urbanism/1387/

BOYD, D. & CRAWFORD, K. (2012): "Critical questions for big data", *Information, Communication & Society*, 15 (5), pp. 662-679.

CAMPKIN, B. & ROSS, R. (Eds) (2013): *Future & Smart Cities* (Vol. 1), London: UCL Urban Laboratory. http://discovery.ucl.ac.uk/1392981/

CHESBROUGH, H. (2003): *Open Innovation*, Harvard Business Press.

CHOURABI, H. *et al*. (2012): "Understanding Smart Cities: An Integrative Framework", *Proceedings of the 45th Hawaii International Conference on System Science* (HICSS), 4-7 January, pp. 2289-2297.

DAVIES, T., PERINI, F. & ALONSO, J. (2013): "Researching the emerging impacts of open data. ODDC conceptual framework", Open Data in Developing Countries, Working Paper 1.

DE LA PEÑA, B. (2013): "The Autocatalytic City", in: BOOKS, T. E. D. (Ed.), *City 2.0: The Habitat of the Future and How to Get There* (Ebook). TED Conferences.

DG Communications Networks, Content and Technology (2013): *Open Innovation 2.0 Yearbook 2013*. European Commission.
https://ec.europa.eu/digital-agenda/en/news/open-innovation-20-yearbook-2013

FERRO, E. & OSELLA, M. (2013): "8 BM archetypes for PSI re-use", *Proceedings of the Open Data on the Web Workshop*, 23 April, London.

FISTOLA, R. & LA ROCCA, R. A. (2013): "Smart City Planning: A Systemic Approach", *Proceedings of the 6th Knowledge Cities World Summit*, 9-12 September, Istanbul, Turkey, pp. 520-529.

GAWER, A. & HENDERSON, R. (2007): "Platform owner entry and innovation in complementary markets: evidence from Intel", *Journal of Economics & Management Strategy*, 16 (Spring 2007), pp. 1-34.

GOEDERTIER, S. (2013): "Study on business models for Linked Open Government Data" (BM4LOGD). https://joinup.ec.europa.eu/community/semic/document/study-business-models-linked-open-government-data-bm4logd

GOLDSTEIN, B. & DYSON, L. (Eds) (2013): *Beyond Transparency-Open Data and the Future of Civic Innovation*, San Francisco: Code for America Press.

GRAHAM, S. (2002): "Bridging Urban Digital Divides: Urban Polarisation and Information and Communication Technologie(s)", *Urban Studies* 39 (1), pp. 33–56.

GREENFIELD, A. (2012): "The City is Here For You to Use: 100 easy pieces", Adam Greenfield's Speedbird. http://speedbird.wordpress.com/2013/05/07/on-augmenting-reality/

GREENFIELD, A. & SHEPARD, M. (2007): *Urban Computing and its Discontents*, New York: Architectural League of New York.

HALL, R. E. (2000): "The Vision of a Smart City", *Proceedings of the 2nd International Life Extension Technology Workshop*, Paris.

HAMDI, N. (2004): *Small Change: About the Art of Practice and the Limits of Planning in Cities*, Routledge, London.

HARRISON, C., ECKMAN, B., HAMILTON, R., HARTSWICK, P., KALAGNANAM, J., PARASZCZAK, J., & WILLIAMS, P. (2010): "Foundations for Smarter Cities", *IBM Journal of Research and Development*, 54(4).

HEMMENT, D. & TOWNSEND, A. (2013): "Here Come the Smart Citizens", in: HEMMENT, D. & TOWNSEND, A. (Eds): *Smart Citizens* (Vol. 4), Manchester: FutureEverything Publications.

IBM (2009): "How Smart Is Your City?", IBM Institute for Business Value, Executive Report. http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03248usen/GBE03248USEN.PDF

JANSSEN, M., CHARALABIDIS, Y. & ZUIDERWIJK, A. (2012): "Benefits, Adoption Barriers and Myths of Open Data and Open Government", *Information Systems Management*, 29(4), pp. 258-268.

JOROFF, M. (2008): *Reshaping the Cities of the 21st Century*, MIT School of Architecture and Planning. http://sap.mit.edu/resources/portfolio/reshaping_cities/

KITCHIN, R. (2013): "Four Critiques of Open Data Initiatives, The Programmable City". http://www.nuim.ie/progcity/2013/11/four-critiques-of-open-data-initiatives/

LINDSAY, G. (2011): "Not-So-Smart Cities", *New York Times*, 24 September. http://www.nytimes.com/2011/09/25/opinion/sunday/not-so-smart-cities.html?_r=0

MUÑOS, C. (2013): "Guerrila Bike Lanes Appear in NYC", *Untapped Cities*, 25 September. http://untappedcities.com/2013/09/25/guerrilla-bike-lanes-appear-nyc-cycling-advocacy-group-right-of-way-6th-avenue/

NAPHADE, M., BANAVAR, G., HARRISON, C., PARASZCZAK, J. & MORRIS, R. (2011): "Smarter Cities and Their Innovation Challenges", *IEEE Computer*, 44, 6, pp. 32-39.

OKFN (2012): "What is Open Data?", *Open Knowledge Foundation, Open Data Handbook*. http://opendatahandbook.org/en/what-is-open-data/index.html

O'REILLY, T.:
- (2007): "What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software", *Communications & Strategies*, No. 65, 1st Q.
- (2011): "Government as a Platform", *Innovations: Technology, Governance, Globalization*, 6(1), pp. 13-40.

Pike Research (2011): "Global Investment in Smart City Technology Infrastructure to Total $108 Billion by 2020", Navigant Research. http://www.navigantresearch.com/newsroom/global-investment-in-smart-city-technology-infrastructure-to-total-108-billion-by-2020

SCHUURMAN, D., BACCARNE, B., DE MAREZ, L. & MECHANT, P. (2012): "Smart Ideas for Smart Cities: Investigating Crowdsourcing for Generating and Selecting Ideas for ICT Innovation in a City Context", *Journal for Theoretical and applied Electronic Commerce Research*, 7 (3), pp. 49-62.

SENNET, R. (2013): "No One Likes a City That Is Too Smart", *The Guardian*, 4 December. http://www.guardian.co.uk/commentisfree/2012/dec/04/smart-city-rio-songdo-masdar

SHEPARD, M. & SIMETI, A. (2013): "What's So Smart About the Smart Citizen?", in: HEMMENT, D. & TOWNSEND, A. (Eds): *Smart Citizens* (Vol. 4), Manchester: FutureEverything Publications.

Smart Cities Project (2011): "Co-Design in Smart Cities - A guide for municipalities from Smart Cities", Smart Cities Project. http://www.smartcities.info/

SOFFEL, J. (2013): "Rio's Big Brother Control Room Watches Over the City", CNN, 29 August. http://edition.cnn.com/2013/08/29/world/americas/rio-big-brother-control-room/

STOTT, A. (2014): "How to get your open data used", Presentation at the Data Days, 19 February, Ghent, Belgium.

TOWNSEND, A. (2013): *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*, New York, NY: W.W. Norton & Company.

UN Department of Economic and Social Affairs (2008): *World urbanization prospects: the 2007 revision* (Vol. 216), New York, N.Y.: United Nations Publications.

United Nations Human Settlements Programme (2012): "State of the World's Cities 2012/2013", Nairobi, Kenya: UN-Habitat.
http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=3387

VANOLO, A. (2013): "Smartmentality: The Smart City as Disciplinary Strategy", *Urban Studies*, 51 (5), pp. 883-898.

VICKERY, G. (2011): "Review of Recent Studies on PSI Re-use and Related Market Developments", Information Economics, Paris.

WALRAVENS, N. (2012): "Mobile Business and the Smart City: Developing a Business Model Framework to Include Public Design Parameters for Mobile City Services", *Journal of Theoretical and Applied Electronic Commerce Research*, 7(3), pp. 21-22.

WASHBURN, D., SINDHU, U., BALAOURAS, S., DINES, R. A., HAYES, N. M. & NELSON, L. (2010): *Helping CIOs Understand "Smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO*, Cambridge, MA: Forrester Research, Inc.

WOOD, D. (2010): *Linking Enterprise Data*, Springer.