Data and the City

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ABSTRACT
We consider how data is produced and used in cities. We draw on our experiences working with city authorities, along with twenty interviews across four cities to understand the role that data plays in city government. Following the development and deployment of innovative data-driven technology projects in the cities, we look in particular at collaborations around open and crowdsourced data, issues with the politicisation of data, and problems in innovating within the highly regulated public sphere. We discuss what this means for cities, citizens, innovators, and for visions of big data in the smart city as a whole.

Author Keywords
smart city; open data; big data; crowdsourced data

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H.5.3. Group and Organization Interfaces: Computer-supported cooperative work

INTRODUCTION
As capabilities for data storage and analysis have increased, and debates around *big data* intensified, much has been promised about, and feared from, the role of data and its impact on ordinary life. In HCI and CSCW, there is a growing interest in tools that support civic engagement that has also lead to an increased awareness of the challenges of effecting change within cities with such technologies [24]. We consider how data is produced and used in cities and how these processes are shaped by local contingencies.

There has also been longstanding interest in the conditions of data use and its connection with system development. Notable here is work looking at data sharing practices in science [4, 25, 26], documenting issues around data sharing, management and production. In the social sciences and humanities, some authors have gone as far as to argue that the database – in its diverse forms – underlies much of the operation of modern society [10 , 11, 17]. Moreover, there has been a turn to critical studies of data, algorithms and software (see, e.g., [1, 12, 15, 19, 20 , 35, 41]).

The deployment of data has been at the heart of arguments for so called "Smart Cities" and attempts to revolutionise the functioning of city life through technology. Yet city governments are bureaucratic organizations, with complex leadership structures, and at times conservative attitudes to innovation [45]. IT development and management is often contracted out to private companies, making for even more complex relationships and incentives involved in data collection and management. Some have critiqued 'smart city' rhetoric as being about corporations attempting to lock cities into particular technological platforms and vendors – something akin to corporate storytelling [22, 29, 45].

As Kitchin [29] writes, the future of the city may not be *smart* but rather "buggy, brittle, and hackable". His work has revealed at length some of the complexities of the use of geographical data to monitor 'real time' city processes. Since the state is the organisation with perhaps the longest history of working with *big data*, there are longstanding concerns about government control and surveillance [17, 29]. This has led to speculations about the panoptic power that *big data* will enable for government and cities [29].

We draw on our experiences of working with our local city government, along with twenty focused interviews in four Northern European cities with city managers or staff working in the city government, and representatives from third party development companies, civic initiatives, and non-profits. We discuss how *data* is integrated into the management of city functions. We focus on the conditions of data use and on how the production and use of data is shaped by local contingencies of influence, power, money, and bureaucracy. At times, discussions over big data can seem to almost give an agency to data itself, as if it existed as a universal resource to be deployed at will. Such accounts overlook the local conditions of how data is produced and used – as Taylor *et al* [44] put it: [how] "data is bound up with place". We consider how managers, staff, and contractors work to produce, use, and manipulate data. Our emphasis is on stakeholders procuring, designing, or building technology, not on the end users and citizens who may be impacted by these technologies, or the resultant decisions based on the collected data.

Issues of ownership and control are at the heart of whom data is collected about, who has access to it, and what it is

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used for. Our analysis illustrates how attempts to innovate or initiatives promoting open data can fail on the back of conflicts over control, finance, *turf*, or the complications of cities' procurement and regulatory responsibilities. By documenting the details of city practice, this paper stands as a corrective – both to speculative assumptions of the power of the smart in smart cities that lack grounding in the everyday practical realities of city functions and, simultaneously, to strong critiques that see new data technologies as part of a broad project of omnipotence and unchecked power. We argue, instead, for a view of data in the city as flawed yet active, managed, innovative but bureaucratic and swept up in pre-existing distributions of power and commerce. Finally, we discuss how we can think about 'big little data' – a multitude of small data initiatives that together can have a significant impact. This leads us to discuss how city data projects, when studied in practice, may not fit comfortably with 'smart city' narratives of success and failure. In terms of future research, we conclude that big data and smart cities work may benefit from close attention to work practice and connections with CSCW's workplace studies programme.

BACKGROUND

We will, first, discuss prior work that interrogates the notions of *big data* and *smart city*. Second, we present a brief review of HCI research on technology in the city, and civic engagement projects in particular.

Big Data

Big data approaches are often depicted as having been produced by contemporary technological capacities to gather, store, analyse and interlink data. Yet, while the term *big data* has become popular only in the past few years, the notion has been around for almost two decades [15]. In an influential piece from 2012, boyd and Crawford [12] push for moving beyond a technological focus by defining big data as "a cultural, technological, and scholarly phenomenon that rests on the interplay of technology, analysis, and mythology that provokes extensive utopian and dystopian rhetoric."

Big Data has prompted expectations of better science, safer cities, and rapid innovation [15]. Some have gone as far as to suggest that finding associations in big data sets and acting on them might be "good enough" to replace the scientific search for causality with correlation [36]. Yet there is also an urgent need for critical reflection on the epistemological implications of big data [28] because of the powerful allure of these empiricist ideas that range from hoping to capture entire domains with full resolution, to doing away with the need for a priori theory, models or hypotheses, or having data "speak for themselves free of human bias or framing". Crawford and Finn [14] point out how simplistic assumptions about the completeness and veracity of data risk leading to analytical and ethical oversights. Big data is not void of limitations, blind spots, or problems of representation [15].

From a study of health care in the U.S., Neff [39] explores how the biggest challenges for using big data are not technical but social. She argues that to fulfil the promise of data-driven approaches to medicine, much has to be done to figure out how both patients and health care providers "will actually use data in practice." At present, many actors see data as costs, risks, and liabilities – not as a source of value, in contrast to the business and technology sectors that advocate big data. Neff's work is indicative of the complexities that governments, citizens, and corporations need to deal with as cities become "increasingly embedded with all kinds of digital infrastructure and networks, devices, sensors and actuators" [29].

Smart Cities

In an adjacent but distinct area of research, "smart city" programs typically seek to understand, manage, and improve city functions, often with a top-down approach, through the use of distributed sensing technology and data processing. The production of sophisticated data analytics for understanding, monitoring, regulating and planning the city is a key issue underlying the idea of "smart cities" [29] – a vision "for stimulating and supporting innovation and economic growth, and providing sustainable and efficient urban management and development."

Townsend [45] emphasises the role of ubiquitous digital technology in improving how cities function and operate. He describes smart cities "as places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems." Yet, he also questions the motivations underlying attempts to transform cities, arguing that "[l]ooking smart, perhaps even more than actually being smart, is crucial to competing in today's global economy", and that such optics may, in fact, be "the real force driving mayors into the arms of engineers." Goldsmith and Crawford [21] point to another challenge cities face in the race to adapt their operations to 'smart' ways of working with technology, where legislation and a rule-bound approach to government becomes an obstacle when working with vast amounts of data generated by the same technology and by the citizens they serve. They argue for a focus on results rather than compliance to legislation, and on problem solving that combines the city's data with collective knowledge and data generated by the citizens.

Kitchin [29] sees exciting opportunities in cities' move to make use of new data streams to help both governments and citizens to make sense of the city, but he points to serious concerns about "the real-time city", too. These include the politics of big urban data, technocratic governance and city development, the corporatisation of city management and the risk of technological lock-in, system vulnerabilities, and ethical issues involved in surveillance and control. Building on the "smart city" critiques by Greenfield [22] and Townsend [45] that advocate for approaches that account for civic everyday realities, Kitchin [29] points out the risk

that, without critical interrogation, future "smart cities" may fail to reflect the desires of wider society and, instead, prioritize narrow corporate and state visions.

The influence global technology firms have on city policies has been a topic of interest in urban geography. McNeill [37] argues that firms' orientation to commercially scalable solutions reduces and oversimplifies cities, and promotes novelty over incremental and entropic change. Shelton et al [43] turn the attention to 'actually existing smart cities', arguing that a more nuanced and situated understanding of how smart city ideas have been implemented and received will be more productive for future data-driven policies. Wiig [47] further stresses the need to move beyond critiquing corporate visions with in-depth, empirical studies of data-focused urban change.

HCI Research On Technology In The City

HCI researchers have presented a range of services that work in the interface between citizens and the city, such as tools for civic engagement that enable citizens to engage with city governance. These include, for example, tools that support civic involvement in democratic processes through situated voting or invite dialogue around politics of place making [16, 31, 44], and technologies that inform city traffic infrastructure and environmental services with the help of mobile sensing and crowdsourced data [2, 23, 32, 48]. Others have proposed systems for improving the accessibility of the city's services and data, for instance, by supporting interaction between families and case workers when planning parental leave [7, 8], by presenting local crime data on mobile devices to reduce fear of crime [6], or by encouraging smarter water consumption [18]. While this body of work does identify complexities in working with data in city administrations, the main emphasis has been on developing and demonstrating new technologies.

Of particular relevance to our present study are two further pieces that address broader challenges in deploying technology within the public sector: First, Le Dantec and Edwards [33] performed a year-long ethnographic study of ICT use in the public sector, looking specifically at ICT projects that cross institutional boundaries. The authors argue that crossing such boundaries is, in fact, a central part of the work in the public sector. They use the notion of *scale* to describe these boundaries and the complexities they present at different levels: *"(...) cooperative systems with large numbers of users (across independent organizations), and long lifespans (as tools for enacting public policy), and whose use encompasses communities that cross local, regional, and national contexts"*. Second, Harding *et al* [24] observe that the perceived value and sustained use of technologies for civic engagement has remained low. They argue that prior work has been, perhaps surprisingly, too citizen-centred, and has, as such, failed to account for the needs and concerns of civic authorities whose responsibility it is to ensure the accountability of the produced data. One conclusion from this work is that interaction between the different stakeholders is needed to overcome mistrust and lack of appreciation of the challenges others face. The authors point to three key aspects to be considered in design processes: 1) how authorities' IT systems are opened to enable new activities with new forms of data, 2) political and organisational factors hindering transparency, and 3) changes that are needed to work practices within cities to support the development and use of new tools.

METHOD

For the last seven years, we have worked closely with our local city authority, a north European capital city, in collaborative research projects where the city has provided us with forums for our research, contacts to participants, and real word problems to be tackled in collaboration with different city authorities, particularly together with the city's youth services department. As part of these projects, we have grown increasingly interested in how the city manages their data. Accordingly, for this paper, we expanded our perspective and collected research materials with a wider scope. We conducted 20 interviews across four Northern European cities – interviewing city management, IT managers, contractors and developers. Seven interviewees were managers or staff working in the city government either in front line positions or managing projects that made use of data and software. The other thirteen represented development companies, civic initiatives, and non-profits.

Our interviewees were selected on the basis that they had key roles in the development of publicly released citizen-facing applications developed directly by the city, in collaboration with the city, and/or commissioned by the city. The targeted applications had to meet the selection criteria that they were 1) data-centric and citizen-facing, either providing citizens access to city data or producing data to be used in city government in some way, or both, 2) past the project phases of funding, planning and development, and to the point of launch (although, as we will see, not all projects launched). By approaching people in different roles in such projects, we aimed to capture a range of perspectives of how data-driven applications are born, developed and maintained, from planning and strategic decisions to building and practical maintenance.

The interviews were semi-structured and lasted between 40 minutes and 1h 20 minutes. The majority of the interviews were conducted in English. In eight instances, interviews took place in the interviewee's native language (other than English). In these cases, the quotes we present have been translated verbatim to English. Our goal in the interviews was to understand different pressures and practices, and to get as broad a perspective as possible on the role that data plays, and how it is managed, in the cities under study. The interviews were informed in part by our experiences in working with our city over a period of seven years. This served as an informative background for our data analysis rather than providing specific data for this study *per se*. We

were not looking for statistically generalizable points, but rather for generating concepts and understandings of data dynamics. As such, our approach to analysing the interviews drew on an interpretivist stance, with the development of an understanding of the problems and practices of those being studied. The analysis involved open coding of the interviews, and the development of themes through an iterative process of concept development.

FINDINGS

Our findings are structured into four sections: First, we address how data, and access to data, is not neutral or seen as neutral. Second, we examine how data is managed and moved across the city, and how cities handle complex concerns related to open data, reputation, and responsibility. Third, we bring up challenges in involving citizens and using crowdsourced data. Lastly, we consider how the bureaucratic nature of the city impacts the usage of data.

Data and *Power*

It is clear from the literature that data can be used to support city functioning. Perhaps surprisingly, though, one of the topics that our participants returned repeatedly was the danger of data being used to *subvert* city functioning. Interviewees brought up that data could be manipulated or controlled by external bodies to cause damage to particular city practices or ways of working. Data could mean, to some extent, power through its control. This meant that access to data and its use had to be carefully managed and could not be necessarily relied upon or expected, even when the relevant information was known to exist.

Two examples come from our discussions with a 'smart city' incubator. This incubator brought a small group of external entrepreneurs and developers together to produce new technologies that made use of existing city data sources. We learned of a city-maintained database of green space, including parks, open spaces and the like. An early application that the incubator proposed was using this database to guide citizens to the greenery closest to them. This idea quickly ran into two problems: The first was that the data necessary for its completion, while seemingly innocuous, was the cornerstone of the provision of gardening service by the city. Lack of knowledge of the number, location, and size of the green areas that needed ground maintenance services, such as grass cutting and hedge trimming, was seen as one of the major factors protecting the gardening service against private sector contractors that might want to bid for these services. So the control of this database by the gardening services department was seen as one way they made it harder for other organisations to bid on the services. This caused an understandable reluctance to share the data for the development of the proposed app outside of the department. The second problem arose around development the difference in time scales between different agencies in the city. As one of the developers remarked to us: "*[the parks and gardens manager] said to me 'I only have to stall until after the summer and then you will be gone.*" The staff who maintained the gardening database could resist requests for access to data by simply 'waiting out' the incubator – which wanted to generate applications on a short six month timescale. Those in charge of the department thus used their control of access to the data as a lever that allowed them to fight against the perceived threat of outsourcing.

In another instance, a private contractor used similar tactics: One important service that cities provide is the maintenance of roads and related surfaces. In one of the cities we studied, the actual repair of road surfaces was contracted out to a private company who then charged the city for each repair made. A process had been set up where potholes were reported through a web form, and the information was then sent to private contractors who physically repaired the roads. This process worked relatively smoothly, if not quickly: First, the council received reports from citizens through email, a website, or a phone call. The reported potholes were checked, documented, and photographed. The resulting details were, then put into a contractor-controlled database and the contractor took on the responsibility to check the condition of the road and fix the problems that were found. Payment was dependent on the order being placed, as a way to move responsibility for longevity of the patches and the decision around the type of patching to be done from the authority to the contractor.

The traffic sector has seen a rise of applications and services such as StreetBump [13], which detects potholes from the accelerometer on citizens mobile devices, and VOTERS [3], which installed sensors on public vehicles. One innovation the city in question decided to explore was the idea of leveraging the citizens who are working as drivers, either in the private sector or for the local authority, to provide the reports of potholes. However, in practice, the contract in place meant that the local authority owned no central database of potholes that had been reported to the contractor. Crucially, the contractor's list of potholes was not available to the city itself – the database connection was unidirectional, so the data got 'captured' by the contractor.

The suspicion of those who we interviewed was that the private contractor made multiple repair invoices for the same repair if it was reported more than once. Moreover, there was no way to replace the system without halting pothole reporting. The only option available for the local authority was to mothball the reporting system until the contract with the repair company was up for renewal, and, at that time, negotiate data access into the new contract. While the incubator developed a better system it was never deployed – one interviewee summed up the unfortunate situation: "*They just hadn't thought about it, and the process behind the system was just impossible … even though it was developed, and deployed, and working we had to cancel the whole thing."*

From a business perspective, it is understandable that the contractor would *not* want the authority to use data that they

have collected and stored in a way that would allow the local authority to easily parcel up the repair contract, giving smaller competitors a chance to bid. While the importance of data was well understood by all the city employees whom we interviewed, this setup was seen as a 'hangover' from a time when data access and control was not on the radar of public officials. The long duration of public outsourcing contracts got contrasted with the speed of technological change, making it hard to keep up and make well-informed decisions: *"We haven't had any situations like that where it's been explicitly an issue. I think part of that has probably been there but for the grace of God"*

These examples shed some light on how data affords power in cities, as well as on how control over data is clearly not a neutral or straightforward matter. Cities have different departments within them, and city functioning is embedded in longstanding relationships and financial commitments.

Data and *Openness*

The significant pressures on cities to make their data open access were another prevalent theme in the interviews. City managers wanted to make data available to the public, in response to higher-level 'Open Data' initiatives from state and country as well as to react to the desires of citizens. There was an understanding of the value of open data initiatives and sharing data with the public and other organisations. However, there were problems in meeting unrealistic expectations that required covering the additional expense of repurposing data for something not core to the city's service provision.

The Challenges of Open Data

The story of the public transport website in one of our case cities shows how the desire for data from citizens can be a driving force for openness. In this city, a local transport body provided a website that gave real-time data about bus and train departures. Even though the agency itself did not make the data available for use by members of the public or other third parties, local programmers in effect forced the data to become open. A number of developers used web-scraping techniques to create alternative clients. The most popular of these was a Microsoft Windows desktop widget that scraped data from the authority's website and displayed local bus and train times. The authority was broadly unaware of the existence of such applications and their operation. As a consequence, when the city's website was updated, rather than failing discretely, the most popular desktop 'widget' started reloading the site continuously in search of the data that it needed to function: *"So when it changed the layout, it became sort of an infinite loop of requests. And then if you have 10,000 installations, you have more or less a denial of service attack."*

This brought down the local authority's website, forcing the city to revert the changes. The staff contacted the developer of the widget, who updated the widget in line with the changes to the website. The event exposed to those in positions of power within the city that even if they tried to avoid making their data formally 'open', as soon as they made it available to citizens digitally in *any* form, the data could be redeployed and repurposed – with scarce control by the city and with the risk of negative consequences. As a positive result, the incident contributed to the formation of an organisation that aimed to open and maintain public transport data across the country, encourage innovation around data, and maintain active relationships with third party developers.

Across all the cities where we conducted interviews, open data was in itself seen as a goal for city data. As one senior manager told us: *"There is a lot of 'heart in the right place-ness' from the council employees and a lot of political will from on high, people genuinely think that open data and freedom of information is a good thing. They also want to be on a Gartner list of the top 10 smart open cities, that is a big motivating factor."*

Yet, our analysis reveals how open data is embedded in complex disputes and issues for cities. First, making data open requires making data *legible* for an outside body. As noted above, this could result in external contractors bidding for jobs that were currently handled 'in house.' Second, formatting and managing data, and making data open, requires resources. To deal with this reality, one of the cities we studied no longer opens a data stream to the public for development purposes until there are at least three project proposals, external or internal, that propose building on top of that data.

Even where there is sufficient demand to drive the opening of a data source, there are issues to consider with both the *fidelity* and *frequency* of data. Some data sources would be collected or updated manually, such as in the case of the green space database. While such a process can fulfil the purpose for which the data is collected in the city, it may not be of a high enough frequency to be useful for third party developers. At other times, data can be insufficiently detailed to be useful to outsiders. To sum up, data can be collected in such a way that it fits a specific purpose but is unusable for other projects. As one developer put it, data might be collected at an insufficient level of precision: *"they might know that there's a community centre, but what you need to know is what is inside the community centre, every class, every community group because that's what makes a difference to the city. So, they're not open, they're not maintained, they're not shared.*"

One example we encountered in multiple cities was bus time data. This can be live data, timetable data, or, simply, rough estimates of the frequency of buses at particular times. While it is possible to make any of these data 'public', they are vastly different in terms of their usefulness to other actors. This issue comes up even with internal development projects. For example, one of the recognised benefits of Open Data initiatives within public bodies is that they not only open data externally, but also make data available across internal department boundaries.

Yet, the fidelity of the data, much like its frequency, is determined by what instigates the data collection in the first place. This means that when a development project requires data with either higher frequency or fidelity than what was originally anticipated, the new project takes on a much more interventionist role in the city.

Reputation and Responsibilities

Moreover, there are risks in making data open. Open data is not just a presentation of impartial data. It can be seen as a presentation of the city, too, even if only in an attenuated form. Fear that any data that is shared may be incorrect, ineffectively anonymised, or correlated with other data in a way that comes to embarrass the city, can work against opening data. This risk aversion meant that the default position was to keep data private, especially data that could be seen as sourced from citizens themselves and potentially traced back to an individual or a group. At times, this reason served, perhaps, as an excuse for some who did not want to take on the work of maintaining a database without receiving extra funding for their team or department.

One example that was discussed with us was a database of driving test passes and fails. Here, making the database publicly available could mean that information about a specific driving test might be made identifiable if the data was sparse enough for a specific area at a specific time. This was the case for geographically located data, too even when data could not be traced back to an individual: *"(…) we had to work within privacy impact and stuff within the council, be compliant with the Information Commissioner's Office. They would check and double check and treble check and that really slowed progress."*

This concern came to an extreme in countries where data could be "forced" public through freedom of information requests. This possibility created a fear that embarrassing data would have to be released. In some cases, this threat even came up as a reason for not computerising particular city functions – that way, data could not be forced public.

While there is a longstanding belief that openness and 'sunshine' are essential to good governance [27], openness may, simultaneously, cause trouble. For example, one city authority put online all the hygiene reports of local restaurants. A restaurant could get a bad rating due to an accident on the day of a hygiene visit or an issue it could repair quickly. The choice to publish the reports caused some controversy in local newspapers, since a less than positive rating might damage a restaurant's business because of a minor, passing concern.

The issues of reputation and reliability come together in the failure of the "Community Support Map" – a grassroots application developed by the incubator we mentioned earlier. This project attempted to leverage community-created, local knowledge, in particular information from a charity that had collected a wealth of data on activities to help support addicts on their path to recovery in a deprived area in the city. Originally, taking the form of a local database developed by one support worker, this resource had been developed to help recovering addicts by providing data on what to do to prevent relapse. As the project manager described it: *"[the charity has] a map of the services that their users can access. And they've done that map. The problem was it was on somebody's laptop so if he wasn't in the office then nobody knew where to go."*

The initial goal of the Community Support Map project was to put the data online, and make them open to those across the city who needed access to the documented services and activities. An initial problem was that the data did not conform to some of the local realities of living in the deprived areas where the services were being provided. The social structure of some parts of the city meant that crossing the borders between neighbouring areas was unsafe. This segregated the services provided by the city based on the geographic territory that they fell into: *"For example [Area 1] and [Area 2] are two different territories and people don't go from [Area 2] to [Area 1]…So to the city, they've put a swimming pool where every inhabitant has a park within X meters of them. Actually, that's not necessarily true because it might be outside of their boundary."*

While building the system, however, the city authority started to consider the sole focus on addiction services problematic, partially because the city had a longstanding problematic reputation around drugs and addiction that it did not want to reinforce. To tackle this, the social and political issues around the categories of services on offer were broadened, so that users of services in one category or subcategory were introduced to further services available in other categories: *"Drug addiction, alcohol addiction and then we had food banks and that made a pretty bleak picture. These are the services that people need. So we made addiction services and made subcategories and then food we had food, we made it food and growing so the food bank and the growing spaces so that they could be the two … And for somebody as well at first they're not going straight for the drug category. They can do something so it changes the perception."*

In trying to aggregate the data from a number of different services, the team came up against problems with presenting citizens with data that was not produced by the particular department – or even by the city as a whole. Here, concerns over the responsibilities and reputation of the city as an information provider became evident again.

Lastly, local city authorities are now well aware of the potential monetary value of the data that they collect – even where that value might be purely speculative and where the city may, currently, be legally and ethically unable to capitalise on it. This meant that city authorities were hesitant to share data that could be either sold or exploited for financial gain in some way, the belief being that such gains should benefit the city, not external actors. This view conflicts with pressures for openness: it was not necessarily

clear when data should be seen to hold potential for financial benefit, and when it should be considered something that should be shared broadly and openly.

Data and *Involving Citizens*

As we have seen here, the city produces a lot of data that can be used for external purposes next to the internal processes that it is generated for. Caution is prevalent in making data public, as well as in presenting public data side by side with crowdsourced data. These dynamics are at work not only for data going out from the city, but also in incorporating data into the city, especially when it comes to data collected by citizens.

For the community map application, the utmost caution was taken in integrating official public data with crowd-sourced data in order to preserve the perception of trust and reliability that the city relied on and cherished. Putting data from different provenances side by side was considered dangerous in this regard. If critical or untrue information was published next to official data, some argued that the official information could be seen as tarnished.

Some applications though had been developed with crowd-sourced data at their heart. An application that had been developed independently in three cities was the use of citizen-sourced cycling data, with an overall goal to leverage that data to improve decision-making on city planning around transport, ultimately to improve conditions for cyclists and in turn promote a healthier lifestyle for citizens. Each of the different cities had different initiatives to collect cycling data either through city-designed apps, citizen initiatives, or by purchasing third party data. Yet, a problem that all three cities faced was how to deploy such data in planning and decision-making in practice.

In one city, by the time the city had established the process for integrating data from citizens to influence planning and decision-making, the original cycle data collection initiative had already been discontinued, and the citizen team working on it had moved on to other projects. While the initiative succeeded in getting citizens to contribute information about problems and wishes related to cycling conditions, it failed in getting that information effectively in front of the decision makers in the city: *"The main problem was that while we did manage to collect feedback to the system, at the time there were no technical means to integrate it to the feedback system of the city."*

The other two city applications succeeded in presenting the data they collected to their respective cities. However, their influence may not, so far, have been any greater because the planning of cycle routes takes place as part of larger, longer-term road development processes, of which cycle routes are only one relatively small part.

The latter two cycling apps have fairly similar functionality: both used GPS to enable the user to track their ride from start point to end point, as well as to calculate distance, average speed and total riding time. Instead of providing cycling enthusiasts with feedback on performance, the initiatives invite cyclists to contribute their route data for further analysis and, where relevant, to be acted upon by the city: *"what we provide is digested information out of this, (...) a report or an analysis with some recommendations, perhaps how to improve cycle planning expenditure"*

Even in the case of a city cycling app that was initiated from within a city-planning department, the resulting data did not seem to feed directly to decision-making processes. All three projects had similar challenges in making staff in the relevant administration within the city understand the value of the data and in achieving the type of impact on decision-making that was intended in the design of the service. Indeed, the app whose development was initiated by the city-planning department got "stuck" in review by the city because of its use of crowdsourced data: *"I think there was a culture of fear around what's going to happen. What if? What if? What if? Which is, again, insanity to have projects that you have constantly fighting against what ifs rather than doing it."*

Although the initiatives were successful in gaining users, and two of them managed to place the data that they collected in the hands of those in relevant departments within the city, none of them has demonstrably succeeded in the goal of influencing the city in a meaningful way, much to the disappointment of the developers involved. This does not mean that the data collected, or even just the awareness of these projects, would not have an impact on the cities in question over time. However, taken together, these initiatives demonstrate the difficulty of creating a functioning feedback loop between cities, developers, citizens who are willing to provide data.

Data and *Bureaucracy*

So far, we have documented aspects of the control and power around data, and the movement of data both in and out of the city. In this final section, we return to the question of the 'conditions of production' of data. In particular, we address the role that the bureaucratic nature of city authorities played in what data was controlled, when, and where, as well as how procurement processes could create perverse effects. The production and management of data was intertwined with the production of particular applications, and the resulting maintenance of those apps and the data they produced and used.

Procurement of Apps

One important issue concerning city governments is that they are bureaucracies, and that they, by their very nature, are constrained and controlled by interactions between regulations, management, and politics. As organisations under democratic control, much of the operation of cities is set out in legislation. In a state organization, rules are produced which are meant to control and restrict behaviour by those in the organization, so as to provide fair, reliable action. Classically, rule following has been foundational to bureaucracies although with the challenge that while rules

are designed as means to ends, they can also become ends in themselves [38]. As writers such as Blau [5] and Wieder [46] have elaborated, rules are contingently used when appropriate, gaining their sense from the situation and use.

Importantly for technological innovations in city, frequently any new projects over a certain size must be *publically procured.* This process means that there is a public bid out for any developer to submit an offer, based on a well-defined and fixed specification of the technology to be developed. This process is in place to secure the interests of price efficiency and quality of work, as well as removing the risk of corruption in contracting processes. The procurement process is noteworthy because it puts a clear price tag on city data as part of the development process.

Despite their justifiable rationale, procurement processes can lead to dysfunctional and downright bizarre practices. In particular, it is known that the requirements for apps often change during the development process, as user needs that were not part of the original specification are identified. In this cases, if the contract specified a particular service or design, the original contract specified design would often be implemented even when it was clear to those involved that something different would serve user needs better.

An example comes from a company that developed applications for paying for parking. The company of one interviewee developed a high quality application in response to a procurement contract with the local authority and was able to 'white box' the product, allowing selling the app to multiple cities. The interviewee highlighted the difference between the single app that they developed for their city authority, with particular services and functionality, and the unbranded version of the app which had since been deployed in multiple cities: *"I don't know how many releases we did last year, but it's like more than 20-25 releases of that app; so it's at least twice per month that we do a release with new features, new functionality, bug fixes, et cetera. So we work a lot on that app. The [city-branded app] was maybe one or two releases. "*

Our interviewee mentioned an inherent problem he saw in the procurement process of city-branded apps as compared to apps on the open market: While the procurement process provided his company with a clear specification for the contracted service, it effectively put a hamper on future development and use of the data the service produced, too. The company proceeded to build technology that would perform analysis on the parking data, and provide the city with valuable information on traffic flows and parking congestion. However, while these new features were added to their commercial app, they could not be incorporated into the city-branded app because they had not been specified during the procurement phase, and would have had to make it through a number of bureaucratic steps to be added at the later stage when they were created: *"(...) the procurement laws, and especially how you interpret what you can do, is not really designed to go hand-in-hand with app development, and software development.*"

Longevity and Sustainability

A second issue around procurement concerns the longevity of projects. For example, one of our participants was involved in the development of an advanced mobile library app that allowed citizens to manage the books they had checked out from the library, and even to transfer a book from one person to another as a peer-to-peer loan. This project had been developed by one of the cities in a metropolitan area where the libraries of several different municipalities collaborated and shared databases. The app was available for use for residents in all of the area's cities, and had a good reception among library users. As an innovative new service, or a "Demonstrator Project", there was financing available for its development – cities often want to demonstrate that they are creating new services, and having the application used by residents in multiple cities was a clearly demonstrable success. Yet, when it came to handling the maintenance of the app, the cities did not reach an agreement over how to share the costs. Ultimately, this lead to the discontinuation of the app – to the dismay of some users who had grown fond of the new service.

The problem here was that the project was 'orphaned': the development of the app served the ambitions of one city, of getting to be seen as developing new, innovative services. Yet, there was no long-term agreement or plan in place to enable the continued provision, maintenance, and development of the service within the larger metropolitan area. There was no single budget holding body that had the resources and interest in place to keep the app functioning. The short-lived success of the library app seems to be a common fate among app-oriented city projects [45]: apps are developed as part of making a city look progressive, but they fall aside if there is no budget or champion to keep the effort running and clear the hurdles to enable a longer lifecycle as a public service.

A similar fate was met by the Community Support Map project. Even though the system was of value to those in need, and those within the city knew and appreciated this, there was only funding for the *development* and even that was only available for a particular period of time as a "Demonstrator Project." This meant that the app could not be broadened and made available for the whole city, even though a local refugee charity had specifically asked for this. It also meant that in the end, the maintenance of the system was left to the charity, which itself was at the mercy of private donations. Similar problems were visible in city-run projects as well. A project manager in a city department summarized her lessons from their first app deployment: *"We cannot just have a development project. We also need to have an administrational project (...) So before you hit the green button on the development project you need to know what the administration on this will involve later. So now I would never produce an application like this without*

knowing what will happen next, what the administration will look like."

What is visible, then, from these projects is that the legal and financial mechanisms inherent in city government seem to enforce a work process that struggles to fit with the customary development processes of data-centric applications. Funding is set according to a specification made at the start of a project, hindering iterative development and shifting focus away from maintenance needs. Unless carefully managed, the procurement process locks resources and removes incentives for project managers and developers to stay engaged.

DISCUSSION

We have looked at the power that data affords to those in control, the paths of data from, in, and through the city, and the regulatory and budgetary influences on data-driven systems development. We now turn back to 'big data' and 'smart cities' to discuss the salient themes in our material in relation to these terms. Moreover, we discuss our contribution to HCI research on urban data and technology, where previous work has aptly shown the potential for sourcing, producing, analysing and presenting data from cities and citizens (see, e.g., [2, 24, 32]). This line of research points to opportunities to impact life in future cities, but it also makes visible both structural and practical challenges for projects that go beyond using the city as a setting for prototype development. For any sustained impact, there is a need to work deeper with longer-term integration with a city's service provision. Our paper builds a more detailed understanding of some of these challenges, paving the way for us, as researchers and practitioners, to move from working *in* the city to working *with* the city.

Big Little Data

An interesting aspect of the data-oriented projects we have addressed here is that, with a few exceptions, they do not necessarily entail what would be considered "big data" in terms of their size or the computational architectures and techniques required for their production and use. Instead, the data we encountered were deeply enmeshed in cities' organisational practices and processes. The majority of the projects we studied are perhaps best understood as gradual improvements on existing city functions and services, rather than as parts of centralized 'big data' or 'smart city' initiatives. They do not constitute a distinct break from some, presumably 'dumb', prior tools and practices, but are rather a continuation of the city administrations' operation. Cities have always striven to be smart.

When talking to people leading IT projects in and with the city, it became apparent that terms such as 'big data' and 'smart city' were seen as distant, high-level, rather abstract constructs. When encountered in cities, they are often catch phrases trickling down from top management rather than something individual departments or projects identify with. Yet, while there may be reluctance to use "big" words, there is, at the same time, a drive to use and produce city data in new ways and to gradually 'smarten' city functions. Decisions on what to develop are pragmatic: a parking app becomes an alternative to paper tickets when smartphone penetration is sufficiently high, and aggregating real-time bus route info is taken up when positioning technology and data processing get reliable enough. These services all had less technically advanced predecessors, and they will have more powerful successors.

While we cannot generalise from our study, it seems that much of the adaptation of data-driven services in cities takes place incrementally and from the ground up, growing out of existing public services. The impact here may then come from multitudes of 'little data', the amalgamation of diverse, different initiatives – rather than an overarching, top-down program – combining to produce a *big* impact from *little* data.

The Smart City Beyond Success and Failure

"*On one hand, Big Data is seen as a powerful tool to address various societal ills, offering the potential of new insights into areas as diverse as cancer research, terrorism, and climate change. On the other, Big Data is seen as a troubling manifestation of Big Brother, enabling invasions of privacy, decreased civil freedoms, and increased state and corporate control. -- [T]he currents of hope and fear often obscure the more nuanced and subtle shifts that are underway.*" [12]

As Kling [30] wrote in 1996, accounts of technology can suffer from both overly optimistic or pessimistic renditions. Talk of cities and data is often stuck in narratives of success or failure. While these stories can be powerful, they may distort and ignore the details of particular situations. The distinction between success and failure is often hard to make, once data innovation in cities is considered *in practice.* It becomes more a matter of stakeholders' differing perspectives, highlighting the social nature of challenges in using big data in bureaucratic settings [39].

We observed several cases of misaligned objectives. From the city's perspective, it may be adequate for a project to demonstrate a potential future use, or, as Townsend [45] put it, to provide an air of innovation and the appearance of technology-enabled progress. Yet, when what the city saw as a demonstrator project did not become a sustained part of the public service offering, contracted developers expressed frustration and disillusionment. This disconnect speaks to what Harding *et al* [24] described as mistrust between actors that risks damaging working relationships. Our examples highlight the need for addressing transparency issues, either through design [24] or through discussing expectations and success indicators explicitly in the planning phases of a project.

Another case of misalignment relates to the *idea* of open data that is being promoted at a state and governmental level, and the messy realities of what it means to collect, curate, control, and disseminate data relating to the lives

and practices of citizens. While there is definite political pressure for local authorities to be seen to be providers of, and even advocates for, open data, this push is, in some ways, almost directly at odds with the current thinking and practice around data in parts of local authority systems.

The problems concerning accountability for any potentially identifiable data, and any negative repercussions that may result in a citizen being identified from information that has been made open, was taken very seriously by all the authorities interviewed. Beyond the harm that such a breech could cause to an individual citizen, city authorities worried also about the potential harm to their reputation that could result from any errors or shortcomings in the data that they were seen to provide. This was reflected in challenges of incorporating data directly from citizens to publicly provided services. As Le Dantec *et al* [32] noted, such data may have great political value, but should not be be assumed to be objective or transparent evidence of the will of citizens. In our examples, authorities were cautious and likely to use and share only the most rigorously – and expensively – checked data. The city's worries with open and crowdsourced data are not irrational, given the level of accountability they have to maintain in the public eye [24] but they often get in the way of what other stakeholders would label success.

As we have documented, the life of data in the city is not necessarily a smooth one. This leads us to be sceptical, on the one hand, of writers who see the coming of big data as simply about new ways in which the state can control citizens (see, e.g., [40]). Our study illustrates how data and control are managed through and with bureaucratic action, and how these efforts suffer from severe challenges. In turn, overly optimistic tales of the smart city may be less about actual city functioning than about attempts to make money from city authorities. The supposedly successful Smart City projects reported in FastCompany [42] on inspection are more about extracting value from the city –be it in charging a percentage of processing fees to administer services online, or documenting and selling (with a fee) unused or underused parcels of public land. We need maintain a healthy academic scepticism and ask, who is benefiting and how. As boyd and Crawford [12] put it: "who gets access? For what purposes? In what contexts?"

Data in Organisations and the Organisations in the Data

We have focused on the role of city organisation in the management and production of data, and we would not assume that other contexts suffer from similar issues. Indeed, much of what we describe comes from the particular role of the city as a public, non-profit entity. The very point of the city and related public bodies is that they take on functions that would be ignored by the private sector, supporting those who would either not have the financial means to buy the services they need, or services which would not be profitable for private enterprise to offer. However, as organisations, or sets of organisations, cities are perhaps not completely unusual. The issues around sharing data and how data is integrated into power relationships, particularly in terms of subcontracting relationships, are not suffered by cities alone.

Thinking about and understanding data may then benefit from CSCW's longstanding interest in the role of the organisation in management and production of technology – the organisation of data may owe as much to the organisation in the data. Obviously, one site where these issues have been discussed at length has been in workplace studies within CSCW [34], that has examined in detail how the practices of technology use interact with its design. Indeed, in the classic 'workflow from within and without paper', by Bowers *et al* [9], one of the discussion points they make concerns how understanding data systems in one organisation may benefit from understanding better the interactions between organisations.

Our suggestion then is that recent interest in big data and smart cities may benefit from the close attention to work practice that workplace studies pioneered. The key factors in understanding why and how data practices work and do not work in different settings may come as much from understanding the role of the organisation, and work practice, as it does from understanding the technical properties of systems and data management.

CONCLUSION

We have looked at data in use in four northern European cities through the lens of the technology projects they undertake. Our arguments have focused on unpacking the local details of the production and use of data, how the city in practice works to both enable and inhibit new applications and services. We teased apart the relationships between data and its ownership, its purpose, its origin, as well as how funding and bureaucracy impact its provision. This was contrasted both with technology centric views of the city-as-a-system, but also more pessimistic views of cities as technologically enabled forms of social control.

While the city has been a longstanding backdrop to much CHI research, as a source of data and as a domain for new technologies, this paper instead builds on a more recent concern in this research – an identified need to understand the city as an actor in developing new city technologies, that is, the city as both an enabler and a gatekeeper to social services and support. Much of the fabric of society relies upon the services that cities provide. The opportunity here is to think of the city not simply as a backdrop to technology innovation, but as an active – even if complex – partner.

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REFERENCES

1. Mike Ananny. 2016. Toward an Ethics of Algorithms Convening, Observation, Probability, and Timeliness. *Science, Technology & Human Values*, 41 (1). 93-117. DOI: 10.1177/0162243915606523
2. Paul M Aoki, RJ Honicky, Alan Mainwaring, Chris Myers, Eric Paulos, Sushmita Subramanian and Allison Woodruff. 2009. A vehicle for research: using street sweepers to explore the landscape of environmental community action. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 375-384. DOI: 10.1145/1518701.1518762
3. Ralf Birken, Gunar Schirner and Ming Wang. 2012. VOTERS: design of a mobile multi-modal multi-sensor system. in *Proceedings of the Sixth International Workshop on Knowledge Discovery from Sensor Data*, ACM, 8-15. DOI: 10.1145/2350182.2350183
4. Jeremy P Birnholtz and Matthew J Bietz. 2003. Data at work: supporting sharing in science and engineering. in *Proceedings of the 2003 international ACM SIGGROUP conference on Supporting group work*, ACM, 339-348. DOI: 10.1145/958160.958215
5. Peter M Blau. 1969. *The dynamics of bureaucracy: A study of interpersonal relations in two government agencies*. University of Chicago Press Chicago, IL.
6. Jan Blom, Divya Viswanathan, Mirjana Spasojevic, Janet Go, Karthik Acharya and Robert Ahonius. 2010. Fear and the city: role of mobile services in harnessing safety and security in urban use contexts. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 1841-1850. DOI: 10.1145/1753326.1753602
7. Morten Bohøj, Nikolaj Gandrup Borchorst, Niels Olof Bouvin, Susanne Bødker and Pär-Ola Zander. 2010. Timeline collaboration. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 523-532. DOI: 10.1145/1753326.1753404
8. Nikolaj Gandrup Borchorst, Susanne Bødker and Pär-Ola Zander. 2009. The boundaries of participatory citizenship. in *ECSCW 2009*, Springer, 1-20.
9. John Bowers, Graham Button and Wes Sharrock. 1995. Workflow from within and without: technology and cooperative work on the print industry shopfloor. in *Proceedings of the Fourth European Conference on Computer-Supported Cooperative Work ECSCW'95*, Springer, 51-66. DOI: 10.1007/978-94-011-0349-7_4
10. Geoffrey C Bowker. 2005. *Memory practices in the sciences*. MIT Press Cambridge, MA.
11. Geoffrey Bowker and Susan Leigh Star. 1999. Sorting things out. *Classification and its consequences*
12. danah boyd and Kate Crawford. 2012. Critical questions for big data: Provocations for a cultural, technological, and scholarly phenomenon. *Information, communication & society*, 15 (5). 662-679. DOI: 10.1080/1369118X.2012.678878
13. F Carrera, S Guerin and JB Thorp. 2013. By the People, for the People: the Crowdsourcing of. *ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 1 (1). 19-23. DOI: 10.5194/isprsarchives-XL-4-W1-19-2013
14. Kate Crawford and Megan Finn. 2014. The limits of crisis data: analytical and ethical challenges of using social and mobile data to understand disasters. *GeoJournal*. 1-12. DOI: 10.1007/s10708-014-9597-z
15. Kate Crawford, Mary L Gray and Kate Miltner. 2014. Big Data| Critiquing Big Data: Politics, Ethics, Epistemology| Special Section Introduction. *International Journal of Communication*, 8. 10. DOI: 1932–8036/20140005
16. Clara Crivellaro, Rob Comber, Martyn Dade-Robertson, Simon Bowen, Peter Wright and Patrick Olivier. 2015. Contesting the City: Enacting the Political Through Digitally Supported Urban Walks. in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM, 2853-2862. DOI: 10.1145/2702123.2702176
17. Kevin Driscoll. 2012. From Punched Cards to" Big Data": A Social History of Database Populism. *communication+ 1*, 1 (1). 4. DOI: 10.7275/R5B8562P
18. Thomas Erickson, Mark Podlaseck, Sambit Sahu, Jing D Dai, Tian Chao and Milind Naphade. 2012. The dubuque water portal: evaluation of the uptake, use and impact of residential water consumption feedback. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 675-684. DOI: 10.1145/2207676.2207772
19. Matthew Fuller. 2008. *Software studies: A lexicon*. MIT Press.
20. Tarleton Gillespie. 2014. The Relevance of Algorithms. in *Media technologies: Essays on communication, materiality, and society*, MIT Press, 167.
21. Stephen Goldsmith and Susan Crawford. 2014. *The Responsive City: Engaging Communities Through Data-Smart Governance*. John Wiley & Sons.
22. Adam Greenfield. 2013. *Against the smart city*.
23. Kotaro Hara, Vicki Le and Jon Froehlich. 2013. Combining crowdsourcing and google street view to identify street-level accessibility problems. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 631-640. DOI: 10.1145/2470654.2470744
24. Mike Harding, Bran Knowles, Nigel Davies and Mark Rouncefield. 2015. HCI, Civic Engagement & Trust. in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM, 2833-2842. DOI: 10.1145/2702123.2702255
25. Mark Hartswood, Rob Procter, Mark Rouncefield, Roger Slack, James Soutter and Alex Voss. 2003. 'Repairing'the Machine: A Case Study of the Evaluation of Computer-Aided Detection Tools in Breast Screening. in *ECSCW 2003*, Springer, 375-394. DOI: 10.1007/978-94-010-0068-0_20

26. Marina Jirotka, Rob Procter, Mark Hartswood, Roger Slack, Andrew Simpson, Catelijne Coopmans, Chris Hinds and Alex Voss. 2005. Collaboration and trust in healthcare innovation: The eDiaMoND case study. *Computer Supported Cooperative Work (CSCW)*, 14 (4). 369-398. DOI: 10.1007/s10606-005-9001-0
27. Deborah G Johnson, Priscilla M Regan and Kent Wayland. 2010. Campaign disclosure, privacy and transparency. *Wm. & Mary Bill Rts. J.*, 19. 959.
28. Rob Kitchin. 2014. Big Data, new epistemologies and paradigm shifts. *Big Data & Society*, 1 (1). 2053951714528481. DOI: 10.1177/2053951714528481
29. Rob Kitchin. 2014. The real-time city? Big data and smart urbanism. *GeoJournal*, 79 (1). 1-14. DOI: 10.1007/s10708-013-9516-8
30. Rob Kling. 1996. *Computerization and controversy: value conflicts and social choices*. Morgan Kaufmann.
31. Matthias Korn and Jon Back. 2012. Talking it further: From feelings and memories to civic discussions in and about places. in *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design*, ACM, 189-198. DOI: 10.1145/2399016.2399046
32. Christopher A Le Dantec, Mariam Asad, Aditi Misra and Kari E Watkins. 2015. Planning with Crowdsourced Data: Rhetoric and Representation in Transportation Planning. in *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, ACM, 1717-1727. DOI: 10.1145/2675133.2675212
33. Christopher A Le Dantec and W Keith Edwards. 2010. Across boundaries of influence and accountability: The multiple scales of public sector information systems. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 113-122. DOI: 10.1145/1753326.1753345
34. Paul Luff, Jon Hindmarsh and Christian Heath. 2000. *Workplace studies: Recovering work practice and informing system design*. Cambridge University Press.
35. Lev Manovich. 2013. *Software takes command*. A&C Black.
36. Viktor Mayer-Schönberger and Kenneth Cukier. 2013. *Big data: A revolution that will transform how we live, work, and think*. Houghton Mifflin Harcourt.
37. Donald McNeill. 2015. Global firms and smart technologies: IBM and the reduction of cities. *Transactions of the Institute of British Geographers*, 40 (4). 562-574. DOI: 10.1111/tran.12098
38. Gareth Morgan. 1997. *Images of organization*. SAGE Publications.
39. Gina Neff. 2013. Why big data won't cure us. *Big data*, 1 (3). 117-123. DOI: 10.1089/big.2013.0029
40. Jathan Sadowski and Frank Pasquale. 2015. The spectrum of control: A social theory of the smart city. *First Monday*, 20 (7) DOI: http://dx.doi.org/10.5210/fm.v20i7.5903
41. Christian Sandvig, Kevin Hamilton, Karrie Karahalios and Cedric Langbort. 2014. Auditing algorithms: Research methods for detecting discrimination on internet platforms. *Data and Discrimination: Converting Critical Concerns into Productive Inquiry*
42. Ben Schiller. 2015. 5 Startups Taking On The Big, Unsexy Problems Of City Government: Changing how government works, under the hood. Retrieved 21-07-2015 from http://www.fastcoexist.com/3046292/5-startups-taking-on-the-big-unsexy-problems-of-city-government
43. Taylor Shelton, Matthew Zook and Alan Wiig. 2015. The 'actually existing smart city'. *Cambridge Journal of Regions, Economy and Society*, 8 (1). 13-25. DOI: 10.1093/cjres/rsu026
44. Alex S Taylor, Siân Lindley, Tim Regan, David Sweeney, Vasillis Vlachokyriakos, Lillie Grainger and Jessica Lingel. 2015. Data-in-Place: Thinking through the Relations Between Data and Community. in *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM, 2863-2872. DOI: 10.1145/2702123.2702558
45. Anthony M Townsend. 2013. *Smart cities: big data, civic hackers, and the quest for a new utopia*. WW Norton & Company.
46. D Lawrence Wieder. 1970. On meaning by rule. *Understanding everyday life. Chicago: Aldine*. 107-135.
47. Alan Wiig. 2015. The empty rhetoric of the smart city: from digital inclusion to economic promotion in Philadelphia. *Urban Geography*. 1-19. DOI: 10.1080/02723638.2015.1065686
48. Daisy Yoo, John Zimmerman, Aaron Steinfeld and Anthony Tomasic. 2010. Understanding the space for co-design in riders' interactions with a transit service. in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 1797-1806. DOI: 10.1145/1753326.1753596