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SURVEILLANCE AND THE SMART CITY : MANAGING URBAN LIFE THROUGH SOFTWARE

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Abstract

Drawing upon Swiss examples from the fields of smart energy and smart traffic management, this paper shows how smart technologies permeate the production and management of urban space and considers the power and surveillance issues that this raises. The paper starts with a discussion of the increasing interconnection and automation of data collection and analysis across urban space, before questioning the changing logics of urban surveillance, from the rigid monitoring of spatial enclosures to more flexible forms of regulation and control of intra and inter-urban flows.

Key-words

Smart city

Surveillance

Big Data

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This paper draws upon three previously published pieces of work, relating to the Foucauldian logics of power inherent in smart energy management (Klauser, 2013; Klauser, Paasche & Söderström, 2014) and dealing with the interactions between surveillance and space (Klauser, 2017). Special thanks to Hannah Juby for her very detailed proofreading of the paper, which contributed significantly to the clarity of the arguments advanced.

1. Introduction

Recent urban policy debates have been heavily influenced by discourses promising that software-driven technologies will improve the infrastructural networks that underpin urban life, such as electricity grids, sewage and traffic systems. As a result, such technologies are being accorded increasing importance, as shown in the fact that almost two thirds of Swiss cities and municipalities now devote a special budget to the development of IT-based smart city projects (Städteverband, 2019: online). The most common types of smart city projects relate to the fields of smart energy, smart traffic, smart environment and smart government (ibid.). Examples from the first two fields will be discussed in this paper. All the fields have in common that they imply a range of technologically mediated forms of control and regulation at a distance, based on orchestrated assemblages of computerized systems that act as conduits for multiple cross-cutting forms of data gathering, transfer and analysis. In other words, the smart city is also a surveillant city, if we understand surveillance as "focused, systematic and routine practices and techniques of attention, for purposes of influence, management, protection or direction" (Lyon, 2007: p.14; see also Murakami Wood et al., 2006). Surveillance is the very condition and price to pay for smart technologies to achieve their proclaimed benefits – simplify everyday life, anticipate individual needs, optimize specific urban systems, etc.

1.1. Surveillance and the smart city

This paper is concerned with the surveillance implications of the smart city. It explores critically the ways in which software-based forms of data gathering and analysis permeate the production and management of urban space, and considers the implications of this for everyday social life. The key questions of this paper are, "How do smart information technologies intervene in the regulation of everyday life?" and "What are the dynamics of power and regulation implied by these technologies?" In answering these questions, the paper explores in particular the power and surveillance issues arising from three intertwined developments that today characterize the functioning of smart technologies, relating to the increasing (1) interconnection and (2) automation of smart technologies, and (3) to the flexible logics of control of urban flows implied (Thrift & French, 2002; Lyon, 2007).

1.2. Surveillance and space

This study has at its core a distinct interest in and concern regarding space and power (Klauser, 2017). It approaches urban space as the object of surveillance (if data gathering focuses on specific geographical locales), as the tool and mediator of surveillance (since spatial organization and architecture can affect the ways in which data is collected and analyzed), as the locus of surveillance (when digital technologies are built into the material environment), and as the product of surveillance (since data collection and analysis can affect how urban space is organized and used).

Theoretical and empirical research has long suggested that surveillance tends not only to relate to specific persons or social groups (Lyon, 2003), but also to select, differentiate and manage specific categories of space (Graham, 1998; 2005; Koskela, 2000; Coleman & Sim, 2000; Franzén, 2001; Belina, 2006; Zurawski, 2014; Klauser, 2017). For example, there is now a growing body of work that points to the influence of surveillance strategies on the ways in which particular places are accessed, perceived and lived. Think of CCTV cameras used to monitor city centers (Coleman & Sim, 2000), to secure parks and transport hubs (Adey et al., 2013), or to regulate consumer behavior in shopping malls (Helten & Fischer, 2004), football stadiums (Hagemann, 2007) or other places of leisure and consumption. From this perspective, important insights have been gained into the socio-spatial effects of surveillance on the 'spheres of the everyday' (Klauser, 2010), relating for example to issues of social inclusion and exclusion (Koskela, 2000).

Another space-sensitive literature on surveillance explores the logics and implications of surveillance relating to the control and orchestration of different types of flows (Murakami Wood & Graham, 2006; Lyon, 2006; Dodge & Kitchin, 2007; Firmino, Duarte & Ultramari, 2011). On the one hand, relevant research is concerned with how digital technologies today permeate the key infrastructural networks underpinning everyday urban life (Debrix, 2001; Wekerle & Jackson, 2005). Examples range from computerized motorways and energy grids, to the digitization of water pipelines and public transport systems. On the other hand, attention has been paid to the surveillant capacities of increasingly mobile, ubiquitous and smart information and communication technologies, with a particular interest in how such devices affect people and objects on the move. This applies for example to smart phones and other self-tracking devices, which work through the continuous geo-localization of mobile people and objects (Dodge & Kitchin, 2007). The place-, user- and practice-specific information and services offered by such devices guide and regulate flows and presences of people and objects as they navigate through urban space (Widmer & Klauser, 2013).

Taken together, these lines of enquiry provide much needed accounts of how surveillance works to align the circulation of mobile bodies, data, objects and services with localization, identification, verification and authentication controls, and of how the practices and techniques of surveillance engage with the key infrastructural networks that aim to filter and manage movements within and between cities (Klauser & Albrechtslund, 2014). More specifically, they point at three main aspects that today characterize the functioning of surveillance. These will be placed centrally in the analysis that follows, thus providing the overall structure of the paper.

First, scholarly accounts portray contemporary surveillance as resulting from the increased possibility to interconnect and fuse a wide variety of data relating to various devices, sites and thus aspects of everyday life. Think of the possibility to interconnect and combine data from personal mobile phones, smart CCTV cameras and road-based sensors to monitor and manage intra and inter-urban traffic fluidity (Netwerk City and Landscape, 2012; Swisstraffic, 2018). Second, they emphasize that surveillance in the world of big data is not merely information generation and transfer, but also involves the processing of information through software in order to generate automatic responses (Thrift and French, 2002; Kitchin and Dodge, 2011). As Murakami Wood puts it, “we now live in a surveillance society under digital rule” (Murakami Wood, 2008: p.95). Third, they point at the high degree of flexibility of contemporary urban surveillance, which can be adapted meticulously and continuously to specific needs, profiles or contextual conditions. For example, specific forms of service provision can be tailored to specific consumer profiles and needs, adapted to changing societal, political and economic agendas and adjusted to technological conditions, network utilization, etc.

Following from these three lessons, the paper aims to study the power issues arising from the increasing interconnectivity, automation and flexibility of surveillance in the smart city. It does so by focusing on Swiss examples relating to the fields of smart traffic and smart energy management. These two fields are chosen to give focus to the discussion that follows, offering two entry points through which to explore the increasingly interconnected, automated and flexible techniques of control and regulation that shape present-day urban life. They allow a study of surveillance in the smart city beyond the usual focus on issues of public safety, thus inviting a more sustained reflection on surveillance in relation to sustainability, efficiency and comfort. They also offer an opportunity to explore how surveillance incorporates parameters relating to both human and non-human phenomena, from the monitoring of motorways to micro-climate modeling and private energy consumption.

2. The interconnection of surveillance

As IBM's Smarter Cities program states, "a Smarter City knows how to collect information from a wide variety of sources, integrate information across departments and agencies, and then use that information to anticipate problems, coordinate services and drive sustainable economic growth" (IBM, 2011: p.3). Here, the smarter city is portrayed as accommodating a range of intersecting efforts of digitization, which aim at the creation of the city of the future as an interconnected 'system of systems' (ibid.). Put differently, the 'smartness' of cities is, fundamentally, related to interconnectivity (Giffinger et al., 2007: p.10). The power and surveillance issues arising from this can be best explored through the discussion of specific examples, which will be my task below.

2.1. Interconnectivity in smart energy and traffic management

The objective of smart grids is to integrate additional, decentralized energy feed-in points into the electricity system (such as private solar panels, for example), favoring the use of renewable energy whilst also guaranteeing grid stability in times of unfavorable weather conditions. In Switzerland, one of the most sophisticated smart grid projects to date is FlexLast (Bundesamt für Energie, 2012), which uses refrigerated warehouses owned by the Swiss retail company Migros as a buffer to help balance fluctuations in the availability of renewable energy on the grid. The project's objective is to model and predict the warehouses' power requirements at any given time, based on warehouse characteristics, expected activity, etc., thus determining the degree of flexibility to reduce energy consumption or to activate reverse electricity flows during periods of either high demand or low availability of renewable energy (Klauser, Paasche & Söderström, 2014). Another such project is iSMART – in the Swiss municipality of Ittigen, close to the city of Bern – which involves the digitization, monitoring and visualization of individual electricity consumption on the household level. The project monitors and quantifies the power generated by residents' solar panels, and studies customer perception and the use of smart metering techniques (Kaegi, Berner & Peter, 2011).

Both projects rely on a complex architecture of interconnected data accumulation and analysis. iSMART, for example, involves two-way communication between smart meters and home appliances, and between households and the energy provider's central communication system. The data are then processed and transferred to web-based mobile devices that enable customers to monitor their electricity consumption remotely. FlexLast combines warehouse sensor data with data supplied by the retail company's logistics and scheduling systems, real-time energy data from the local electricity provider and grid operator, and even weather forecasts (Glick, 2012; IBM, 2012).

Smart traffic management conveys a similar logic of interconnectivity. Consider the example of Pully, a municipality of 17,000 inhabitants near the city of Lausanne. Since 2015, in collaboration with Swisscom (a major telecommunications provider in Switzerland) and the Swiss Federal Institute of Technology in Lausanne (EPFL), Pully has set up the pilot project 'Mobility Observatory' (Pully, undated), which monitors and analyzes the movements of motorists, cyclists, pedestrians and public transportation users across the village center, based on anonymized and aggregated network traces generated by Swisscom's mobile network. Aiming at 'data-driven urban infrastructure decision making' (Rollier, 2016: online), the project captures all of the 'interactions created when a smartphone "talks" to a mobile communications antenna, such as phone calls, SMS, app synchronizations, etc. and transforms them into traffic indicators' (Rollier, 2016: online). In future years, the project is also expected to integrate in-situ measurements by street-inbuilt sensors, for presence detection, traffic counting and, subsequently, traffic analysis and automated management (e.g. for the purposes of lighting control, detour routes, temporary closures, etc.).

On a Swiss National scale, Swisscom and the Swiss Federal Roads Office have run a pilot project that uses mobile phone data to evaluate traffic fluidity on motorways, to automatically adapt speed limits in response to traffic levels, to provide information to drivers via electronic road signs, and to provide dynamic route planning via navigation systems (SDA, 2013). The project further extends a range of preexisting efforts to make motorways more 'intelligent' through smart technologies such as stationary software-equipped CCTV cameras for traffic counting and analysis; meteorological gauges for wind, opacity, CO2 rate and temperature measures; and instruments for the automated detection of, for example, ice on the road or fires in tunnels (Klauser, November & Ruegg, 2006; Dodge & Kitchin, 2007). These digital technologies transform the motorway into an 'augmented space', a "physical space overlaid with dynamically changing information, multimedia in form and localized for each user" (Manovich, 2006: p.219; Duarte & Firmino, 2009).

2.2. Surveillance implications

All the projects mentioned above respond to the same basic problematic: How can the individual and infrastructural levels of traffic and/or of energy production and consumption be better aligned with each other? In all cases, the response to this question involves interconnected digital technologies – and thus increased ways to accumulate and interconnect a variety of data – operating seamlessly and automatically in the background of everyday life (Hollands, 2008). At least four main aspects stand out if we look at the resulting dynamics of surveillance.

Continuous expansion of surveillance: In order to be effective, the described smart-city projects involve a level of regulation that is aiming to decipher and interlink ever more extensively and intensively approached components of reality. For example, only if personal energy consumption or specific traffic pattern are known in detail and related to as many other contextual phenomena as possible, such as weather or air pollution for example, can they be better aligned with the patterns that characterise the offer of electricity or public transport. In surveillance terms, this implies a continuous expansion in data collection and analysis across an increasing range of spheres of life, often without explicit popular consent. Smart meters, for example, generate data that provide insight into individual habits and movement patterns (for example, the time at which a person takes a shower, leaves the house or watches TV). These data can serve secondary purposes, ranging from personalized advertisement to political oppression.

Distantiation of surveillance: Whether we are talking about smart grids, sensors inbuilt in road infrastructures or handheld self-tracking devices, the key point is that information is being recorded somewhere and subsequently transferred, accumulated and analyzed elsewhere. What we see emerging is a form of geographically, socially and institutionally distributed agency with regard not only to who generates data, but also who can access the data fused and interconnected within the complex 'surveillant assemblages' (Haggerty & Ericson, 2000) of everyday life. Consequently, from the perspective of the population, it becomes ever-more difficult to know who has access to what data, which raises major concerns in terms of accountability and the transparency of the actor networks that make these systems work. Where and how are decisions made about the masses of data accumulated, interconnected and analysed? What interests do these data politics serve? Today, it is all the more important to consider these questions critically, given the increased public-private interdependences and forms of co-operation that lie behind smart-city projects. For example, FlexLast involves a cooperation between IBM, BKW (the electricity provider in the canton of Bern), Migros and the Swiss Federal Office of Energy (which provided the project funding). Other smart-city projects involve public-private cooperation and interdependences of similar complexity. Given these complex actor networks lying behind contemporary smart city projects, it is ever more difficult to know and legally regulate which party has access to what kind of information and which party has what kind of authority to act on and with the accumulated data.

Multi-scalarness surveillance: Surveillance in the smart city works on all spatial scales. It is intrinsically woven into the micro-spaces of the everyday (as in the case of smart meters, for example), embedded in both inner- and intra-urban infrastructures (from electronic parking guidance systems to smart electricity grids), and suffuses national and global communication networks (mobile phone networks, GPS systems, etc.). Just as surveillance influences these spaces in many ways, space, on differing scales, also affects the functioning and impacts of surveillance. Traffic and electricity grids, for example, allow specific sensor-based forms of surveillance; roadside obstacles may obstruct the view of CCTV cameras for traffic counting, or traffic corridors may channel movements and allow checks along predefined passage points. The smart city, as a burgeoning socio-technical universe in constant transformation, is both the product and producer of specific ways of accumulating and analysing data on all kinds of social and spatial scales, which often reach beyond national jurisdictions and democratically legitimised forms of control.

3. The automation of surveillance

The key point about smart-city projects is not only the interconnection of data-accumulation, but data procession through software. At their very core, efforts to make cities 'smarter' imply a world of regulation at a distance that relies, fundamentally, on the coding of everyday life into software, with a view to generating an automatic response (Haggerty & Ericson, 2000; Lyon, 2007; Graham, 1998). As Morais puts it, "intelligent media artefacts are now embedded into the very fabric of our existence; they have become the structure of society itself. Ubiquitous computing creates informational environments in which material structures of communication become alive with agency" (2014: p.1). The fields of smart energy and smart traffic management bear striking testimony to this.

3.1. Automation of smart energy and traffic management

The aforementioned projects FlexLast and iSMART not only aim to digitize and interconnect their various components of the Swiss energy and traffic systems, but also convey an ambition to elaborate novel software solutions that enable the automated management of these systems. While automation is modest in the case of iSMART, being limited to the automatic heating of residential hot water tanks, it is far-reaching in the case of FlexLast. The challenge here is to model the warehouses' power requirements at any given time, based on their characteristics and expected logistic activity, thus determining the potential to reduce energy consumption or to activate reverse electricity flows during periods of either high demand or low availability of renewable energy. In other words, drawing upon various data sources relating to the grid and to the warehouses, FlexLast elaborates computer algorithms that serve as analytical and predictive tools to calculate and model both the potential for and necessity of peak leveling.

Smart traffic management, in turn, aims to provide automated navigation advice for car drivers, to automatically adjust speed limits and traffic lighting, and to increase access to specific places or detour routes. Again, the objective is not only interconnected data generation and transfer, but also software-based data analysis and automated infrastructure management.

3.2. Surveillance implications

While the software-based processing of data may enable greater efficiency, convenience or security, it also implies invisible processes of classification and prioritization, which affect the life chances of individuals and social groups in ways that are often opaque to the public and that easily evade conventional democratic scrutiny. For example, in developing novel solutions for bidirectional energy flows on the electricity grid that favor more decentralized energy sources, both iSmart and Flexlast differentiate and positively or negatively discriminate varying sources and flows of energy, some of which are facilitated and endorsed while others are considered less attractive and are gradually reduced. The critical question herein is who has the authority to define which energy sources are to be privileged and which ones are not.

Similar logics of positive or negative discrimination can also be observed in smart traffic management. Consider the following quote, from the company that provided the ground-based sensors for Zurich's parking management system:

> The TAPS [traffic and parking management system] sensors immediately send a notification when a vehicle has parked or stopped in a prohibited area. Some parking spaces can only be occupied by certain vehicles or groups (police, fire department, ambulance, etc.). We can use permits for these purposes. […] With our platform, we are able to define exact parking regulations and monitor time-limited zones in city centres. […] We can use our TAPS sensors for the parking lots of residents of residential areas or condominiums. In combination with permit management, this is the most efficient protection against unauthorized parking. […] The shared use of such parking spaces for visitors or neighbours can be varied as required (Lts, online).

As demonstrated in the quotation, smart parking management can be used for all kinds of reasons, in manifold ways. This exemplifies that software-mediated techniques of surveillance are never neutral. They imply predefined codes that are used to assess people's profiles, levels of risk, eligibility and levels of access to a whole range of spaces and services, thus installing a new kind of 'automatically reproduced background' to everyday life (Thrift & French, 2002: p.309). As Graham puts it, "code-based technologized environments continuously and invisibly classify, standardize, and demarcate rights, privileges, inclusions, exclusions, and mobilities and normative social judgements across vast, distanciated domains" (Graham, 2005: p.563). Computer algorithms constitute not only a tool of analysis but also a 'grammar of action' (Galloway, 2004; Kitchin & Dodge, 2011). As a model and technique of analysis, they simplify reality into a legible order (Budd & Adey, 2009: p.1369); as a means of automatic response, they perform everyday life through this order. Thus software-based surveillance is both produced by and in turn produces specific classifications and orderings of reality.

The critical power issues to address relate to the codes themselves. Questions to ask in this regard include the following: How are socio-spatial practices and relationships translated into code? How are these codes applied and what are the socio-spatial implications of this? What particular intentions and strategies do the codes aim to fulfil? How do these codes mediate the organization and production of particular places? And, therefore, how do these codes contribute to the orchestration of everyday urban life?

In addressing such questions, research into the digitization of present-day life has highlighted the growing reliance on private companies and technical expertise in defining, optimizing and managing the 'control by code' (Laon, 2007: p.100) of urban systems and services. Managing urban systems, indeed, means to make use of the mediating means and mechanisms involved in associating the masses of data generated and processed and in coding urban life into software. Thus authority derives from the expertise necessary for the design and use of computer algorithms needed to control, sort and associate the masses of data generated. This gives more weight to certain forms of techno-scientific expertise, which are commonly held by private high-tech companies, and puts traditional modes of governance at stake by challenging decision-making processes that were traditionally placed under the responsibility of the nation-state.

Remember that in both FlexLast and iSmart, IBM plays a central role. The projects are to be considered as two pieces in IBM's global smarter cities campaign, launched in 2008. As shown by Townsend (2013: p.64), studies done by senior IBM cadres in the early 2000s had identified cities as a huge untapped market. In order to obtain the largest possible share in this market, IBM developed a strategy involving two elements: firstly, a "full-scale contracting for city governments" (McNeill, 2013, p.7) with flagship contracts such as those with Singapore and Rio; and secondly, its 'Smarter Cities Challenge' where experts provide municipalities over the world with pro bono consultancy in the hope that this initial investment will yield returns. This allowed the company to claim that its expertise is based on an involvement with 2,000 cities worldwide (Wiig, 2015: p.262). On the whole, as Hollands notes, "this strategy has clearly paid off" (2013: p.9). It makes IBM the market leader in the business of smart urban technologies (ReportBuyer, 2015). The key point here is that IBM, legitimized by its technical expertise and boosted by its marketing and selling campaign, is today aiming at becoming an 'obligatory passage point' (Latour, 1987) in the organizational settings and coalitions of authority underpinning and shaping the smart-city field (Söderström, Paasche & Klauser, 2014). There are two interrelated implications of this to highlight.

Firstly, the central position of commercial players such as IBM in contemporary surveillance developments raises the critical question of how commercial goals, particularly when they intersect with public interests, situate themselves in relation to wider considerations in terms of accountability and efficiency, techno-dependency and data sovereignty, but also with regard to the power structures inbuilt in novel, inherently surveillant, IT solutions that subsequently affect the life chances of individuals or social groups (for example, through predefined modes of classification and prioritization in algorithms). Relevant questions are: How do the increasing weight and scale of private authority change the way in which the codes are being elaborated that subsequently orchestrate social life? And more generally, in what ways are private business companies promoting and indeed pushing forward contemporary surveillance dynamics?

Secondly, IBM's and other high-tech companies' central position in contemporary smart city projects has to be viewed along with its broader effects in framing social and urban issues as technical problems (Vodoz, 2013). As Bell argues, the technocratic vision of smart cities advocated by actors such as IBM, Siemens, Cisco, etc., "frames all urban questions as essentially engineering problems to be analyzed and solved using empirical, preferably quantitative, methods" which give "pre-eminence to urban phenomena that can be measured and are deemed important enough to measure" (Bell, 2011: p.73). Contemporary smart-city agendas, in their reliance on commercially driven stakeholders, may thus well impact on our very understanding of, and engagement with, the city of the future.

Questionning these implications and issues critically is all the more important if we consider that a number of milieux and places, such as airports, motorways, supermarkets, etc., are now completely dependent on software-mediated forms and formats of regulation, a phenomenon that Kitchen and Dodge have termed 'code/space' (Kitchin & Dodge, 2011). "Code/space occurs when software and the spatiality of everyday life become mutually constituted, that is, produced through one another. […] For example, a check-in area at an airport can be described as a code/space. The spatiality of the check-in area is dependent on software. If the software crashes, the area reverts from a space in which to check in to a fairly chaotic waiting room" (Kithin & Dodge, 2011: p.16–17). Thus surveillance, together with its reliance on private actors and technical expertise is today inbuilt in the very spaces of the smart city themselves.

4. The flexibility of surveillance relating to urban flows

As mentioned in the paper's introduction, a growing body of work is now exploring the ways in which surveillance relates to mobile populations, objects or wealth, thus opening up new ways of thinking about governing of and via differing types of flows (Dillon and Lobo-Guerrero, 2008). These studies have produced powerful accounts of the intertwined impulses to facilitate, accelerate and promote flows of people and objects on the one hand, and to reinforce enclosure and restrict accessibility on the other, which characterize the regulatory dynamics inherent in contemporary processes of globalization (Bauman, 1998: p.88; Aas, 2005: p.200). Furthermore, there are accounts that study surveillance as it relates not just to border and access control, but also to the continuous localization and management of objects and people on the move on all kinds of spatial scales (Leistert, 2013; Klauser and Albrechtslund, 2014).

4.1. Flexibility of smart energy and traffic management

The smart energy and traffic projects discussed must be understood from this perspective. They have in common that they accommodate a range of intersecting efforts which aim to manage urban and inter-urban systems as an ensemble of digitized connections and flows. One way in which this works is through sensor-based infrastructure management, allowing the channeling, monitoring and restriction but also facilitation and speeding-up of various types of flows. The examples discussed relate to computerized motorways and energy grids, but many other examples could also have been provided, in the fields of water management, sewage systems, and so on.

Another way in which smart technologies work is through mobile devices (smart phones for the monitoring and visualization of energy consumption in the case of iSMART, or navigation systems in cars in the case of traffic management), based on the continuous geo-localization of people and objects on the move (Dodge & Kitchin, 2007). The place-, user- and practice-specific information and services offered by such devices affect, guide and regulate movements of people and objects across the city (Crampton, 2007; Widmer & Klauser, 2013). What matters is not fixing and enclosing particular places, people, objects and functions (Farman, 2011; Monahan & Mokos, 2013) but, as Michel Foucault stresses in his conceptualization of the ‘apparatus of security’ (Foucault, 2007), “allowing circulations to take place […] in such a way that the inherent dangers of this circulation are cancelled out” (2007: p.65).

4.2. Surveillance implications

This management of flows and openness implies a logic of surveillance that is fundamentally flexible in its functioning. Surveillance does not start from a predefined understanding of the permitted and the prohibited, but from the study and identification of the different ‘normalities’, or patterns, characterizing a given reality (Klauser, Paasche & Söderström, 2014). Consider the above examples of smart energy management in Switzerland. In the case of iSMART, targets for modified energy consumption are set, refined and continuously readapted by each project participant individually, depending on their household needs and goals. This flexible approach mirrors the now myriad techniques used by individuals for tracking, quantifying and documenting various aspects of everyday life for purposes of self-surveillance and self-optimization (Albrechtslund, 2013). Individuals are free to decide if and how they want to participate in the use of such technologies. Yet this freedom to decide is informed and governed on all kinds of levels and in all kinds of ways. In the case of iSMART, this includes financial incentives, information campaigns, advice generated by software or solicited from customer advisers, and techniques such as apps that simulate alternative energy models or measure the energy consumption of appliances. Together, these mechanisms form a mode of regulation that does not work through rigid prohibitions or prescriptions, but acts on the customers’ own desire to optimize their electricity consumption.

In the case of FlexLast, the flexible logic of surveillance and regulation can be seen on at least two levels. On the warehouse level, by calculating and modeling the buildings’ thermal buffer potential, the project allows for more flexible management of the warehouses’ air-conditioning demands. On the grid level, the warehouses’ buffer potential offers increased flexibility to compensate for the fluctuations in the availability of renewable energy. Both levels allow supply to be matched with demand within a flexible “multivalent and transformable framework” (Foucault, 2007: p.20).

Yet both iSMART and FlexLast work through techniques of calculation that not only aim to decipher and align the internal complexities of interrelating fields of reality, but also help ascertain the relevant levels on which the system is confined. The notion of the 'acceptable', acknowledged and calculated in both projects with regard to customer preferences, logistical needs, political stipulations, etc., testifies to this problematic. In this sense, both iSMART and FlexLast are shaped at their very core by the search for the right balance between fixity and flexibility.

This is similar in the case of smart traffic management. Speed limits, detour routes and levels of access to specific spaces are tailored in differentiated ways to differentiated needs (those of car users, city authorities, etc.), adapted to changing political and economic agendas and adjusted to variable contextual conditions. Again, this implies a need for continuous adaptability, which relies on data accumulation, analysis and software-driven, i.e. automatic, responses. In other words, as the software-driven technologies that underpin daily life increasingly come to be accepted and seen as normal, we are moving from a universalist model of services to a model in which individuals can approach the spaces and services of everyday life as commodities that they can adapt to their specific needs and wants.

The necessary flexibility of smarter technologies gives the smart city an inherently fluid and flexible 'software sorted geography' (Graham, 2005). In recent years, scholars have started to address this problematic through the lens of Deleuze's essay on the 'society of control' (Deleuze, 1992; Boyne, 2000; Lianos, 2003; Murakami Wood, 2010), through Foucault's concept of 'security' (Amoore, 2006; 2011; Klauser, 2013; Klauser, Paasche & Söderström, 2014), and in connection with Bauman's understanding of 'liquid modernity' (2000). As David Lyon put it in a recent conversation with Zygmunt Bauman, "it is crucial that we grasp the new ways that surveillance is seeping into the bloodstream of contemporary life and that the ways it does so correspond to the currents of liquid modernity" (Lyon & Bauman, 2013: p.152). It would be useful to make Lyon's comment the starting point for a more sustained and systematic enquiry into the nature and functioning of software-based forms and techniques of surveillance in the contemporary world of smart technologies.

5. Conclusions

The fields of smart energy and smart traffic management exemplify the increased possibilities that now exist for interconnecting data sources situated on multiple geographical scales, and for processing and analyzing the data thus generated in automated and flexible ways. This not only provides a symptomatic picture of the logics of surveillance conveyed by contemporary smart city projects, but also exemplifies how data accumulation and analysis are today woven into the very fabric of the city, hence producing a complex architecture of control that underpins everyday urban life.

Generally speaking, this highlights the manifold ways in which surveillance techniques relate to, focus on and project themselves into urban space, become inscribed there and, in the process, contribute to the very production of the spaces concerned. More specifically, regarding the spatial orderings produced by surveillance in the contemporary world of big data, the key point of the emerging 'surveillant assemblages' (Haggerty & Ericson, 2000) of the smart city is to embrace and manage circulations. The smart city appears as a vast 'program of government of movement' (Côté-Boucher, 2008), which relies on and produces a complex and ever-expanding architecture of data transfer and integration, with a view to the automated management of urban systems and flows.

Related policy discourses are heavily channeled through visions of technology-induced progress, efficiency, cost reduction, urban well-being, security, environmental protection and sustainability. Yet if surveillance is the price to pay in order for smart city projects to achieve their proclaimed benefits, this brings to the fore a series of critical issues associated with the increased possibilities of knowing and tracking daily life. These include effects on privacy and social trust, a lack of accountability and transparency, increased techno-dependency and vulnerability, the risks associated with information sharing, the potential of social discrimination, and the role of private interests in the design and use of smart urban systems.

Future research should approach these issues empirically and from a micro perspective, centered on the actors, interests, organizational settings and coalitions of authority that underpin current efforts towards the software-mediated governing of urban life. Through the study of particular pilot projects and sites, the specific rationales built into smart city projects can be explored and questions can be asked about the way in which these rationales then affect the practices and relationalities managed through code.

In this, it will be important to critically deconstruct the 'language games' (Söderström, Paasche, and Klauser, 2014: p.307) around smart city projects and to study the performative role of 'sustainability talk' around smart city initiatives (Bell, 2011). Furthermore, it will be necessary to explore how exactly issues of sustainability are understood and addressed in particular smart city projects and how novel ideas and models of the smart city are being produced and subsequently circulated on a global scale. In turn, it will be important to gain insight into how these models affect the ways in which smart cities are understood, regulated and reproduced, and how these projects might then change the ways in which urban residents themselves relate to the spaces concerned. Often, the specific needs, difficulties, reservations and expectations of people themselves about novel smart city approaches and projects remain unclear. Yet only by taking into account the societal hopes and fears that crystallize around smart technologies can we understand when, why, and how novel solutions in the field succeed or fail, and in what ways smarter technologies might produce a better quality of life, or not.

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