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Governmentality and urban control

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Introduction

Since the 1950s digital technologies have been used by governments in the global North for the purposes of managing populations and delivering services. Over time, with the development of more sophisticated hardware and software, and the creation of the internet, the use of digital technologies for the purposes of governance has expanded in scope and depth. This has included the use of computation to monitor, manage and govern urban infrastructures and systems (Mitchell, 1995; Graham and Marvin, 1996). From the late 2000s, networked digital technologies that algorithmically produce, manage, analyse and act on streams of big data to augment and mediate the operation and governance of urban systems and life were branded as smart city technologies (Townsend, 2013). Such technologies include: city operating systems, integrated control rooms, coordinated emergency management systems, intelligent transport systems, smart energy grids, smart lighting and parking, sensor networks, building management systems, social and locative media, and city apps.

A number of scholars have argued that a key transformative effect created through the adoption of smart city technologies is the reconfiguring of urban governmentality and the practices of governance (Kitchin and Dodge, 2011; Braun, 2014; Gabrys, 2014; Klauser *et al.*, 2014; Vanolo, 2014; Davies, 2015; Sadowski and Pasquale, 2015; Luque-Ayala and Marvin, 2016; Krivy, 2018). The general conclusion is that algorithmic forms of governance are producing a shift from disciplinary forms of governmentality towards social control. For Foucault (1991), governmentality is the logics, rationalities and techniques that render societies governable and enable government and other agencies to enact governance. Every society is thus organised and managed through a system of government and governance underpinned by a mode of governmentality. The nature of governmentality mutates over time and periodically its form can shift fundamentally in character, for example, in the shift from a feudal society to modern society, wherein more systematised means for managing and regulating individuals through centralised and institutionalised control were introduced.

Through a series of essays, Foucault (1977, 1978, 1991) argued that modern governmentality – through its interlocking apparatus of institutions, administration, law, technologies, social norms and spatial logics – exercises a form of disciplinary power designed to corral and punish transgressors and instil particular habits, dispositions, expectations and self-disciplining. A key aspect of disciplinary governmentality is that people know that they are subject to monitoring and enrolment in calculative regimes. This has entailed the rollout of procedures and technologies for the systematic, wide-scale generation and assessment of data about them and their actions. In general, monitoring has been periodic, somewhat haphazard, and enacted by people working for institutions.

The implementation of algorithmic forms of governance greatly intensifies the extent and frequency of monitoring and shifts the governmental logic from surveillance and discipline to capture and control (Deleuze, 1992; Agre, 1994) through the use of systems that are distributed, ubiquitous, generate and utilise big data, and increasingly automated, automatic and autonomous in nature and work in real-time (Dodge and Kitchin, 2007; Kitchin, 2017). Here, people become subject to constant modulation through software-mediated systems, such as a transport network controlled by an intelligent transport system or a fuel consumption gauge in a car that continually displays miles per litre, in which their behaviour is directed explicitly or implicitly nudged rather than being (self)disciplined. In these examples, driving is modulated by the traffic light sequencing and the act of driving itself becomes a site of administration (Dodge and Kitchin, 2007; Braun, 2014). In other words, governmentality is no longer solely about subjectification (moulding subjects and restricting action) but about control (modulating affects, desires and opinions, and inducing action within prescribed comportments) (Braun, 2014; Krivỳ, 2018).

Rather than power being spatially confined and periodic, 'exercised across a network of heterogeneous institutional enclosures – each one possessing its own self-enclosed monitoring system that envelops the targeted population in a homogeneous disciplinary effect', systems of control are distributed, interlinked, overlapping and continuous, enabling institutional power to creep across technologies and pervade the social landscape (Martinez, 2011: 205). For example, as Davies (2015) notes with respect to Hudson Yards (a smart city development in New York that is being saturated with sensors and embedded computation), residents and workers will be continually monitored and modulated across the entire complex by an amalgam of interlinked systems. The result will be a quantified community with numerous overlapping calculative regimes designed to produce a certain type of social and moral arrangement, rather than people being regulated into conformity within certain institutional enclosures (such as schools and work places) (Martinez, 2011; Davies, 2015; Shepherd, this volume).

Many smart city technologies enact social control because they are cybernetic systems that function through dense and simultaneous feedback that modulates the performance of an infrastructure and those captured within it (Braun, 2014; Davies, 2015; Krivỳ, 2018). From this perspective, the city becomes a system of systems, as initially argued by cybernetians 50 years ago (Forrester, 1969) and reanimated more recently in smart city discourses (Townsend, 2013). Krivỳ (2018) contends that contemporary smart city systems are forms of second-order cybernetics that utilise positive feedback in a continuous process of self-organisation. That is, they recognise: the open, non-linear, emergent and complex properties of cities and expect unintended consequences and side-effects; and that people act as 'sensors' that feedback and shape the unfolding management rather than simply being acted upon. Within these systems '[t]he cumulative character of data streaming effectuates positive feedback loops whereby certain behaviours are amplified while others are hindered', and social change occurs through the 'accumulation of multifarious but infinitesimal behavioural adjustments' (Krivỳ, 2018: 23). As noted by Sadowski and Pasquale (2015), this shift to control has also been accompanied by a shift from a social contract between the state and citizens, to corporate contract wherein city services are delivered through public–private partnerships or private entities only.

The tactics and techniques of governmentality are highly varied, utilising a range of technologies, each of which can be configured and deployed in different ways. More fundamentally, the nature of governmentality can be diverse, with several related and overlapping forms of governmentality enacted and promoted by different entities at work at the same time (Ong, 2006). For example, just as disciplinary power never fully replaced sovereign power, control might supplement rather than becoming dominant to discipline (Davies, 2015; Sadowski and Pasquale, 2015). In other words, just as there are varieties of capitalism (Peck and Theodore, 2007) and varieties of neoliberalism (Larner, 2003; Brenner *et al.*, 2010) – shaped by national and local political economies, political ideology, state policies, institutional cultures, market practices, legal frameworks, public sentiment, etc. – there are varieties of governmentalities (Ong, 2006). Indeed, Ong (2006) argues that contemporary governmentalities have mutable logics which are abstract, mobile, dynamic, entangled and contingent, being translated and operationalised in diverse, context-dependent ways. From this perspective, forms of power and control invested in and enacted by smart city technologies are mutable, even within classes of technologies, driven by differing value systems and dependent on local and national institutional politics and policies and practices of deployment.

The challenge then is to map the forms and practices of governmentality with respect to the smart city – what Vanolo (2014) terms 'smartmentality' – detailing the mutable ways in which the logics of power and control are formulated and enacted. We provide an initial exploration of such a position through a case study examination of two smart city technologies: urban control rooms and city dashboards. In the first section, we document, in general terms, the use of these technologies in urban governance. We then extend this analysis and critique by considering the logics of power and control embedded within and exerted by each and their (re)production of certain modes of governmentality. We do this through an examination of the Dublin Traffic Management and Incident Centre (TMIC) and its use of SCATS (Sydney Coordinated Adaptive Traffic System) to control the flow of traffic in the city, and the Dublin Dashboard, a public, analytical dashboard that displays a wide variety of urban data. Our analysis is based upon ethnographic research conducted in TMIC in 2015/16 (see also Coletta and Kitchin, 2016) and building and operating the Dublin Dashboard (see Kitchin *et al.*, 2016).

Smart cities and urban governmentality

Urban control rooms

Accompanying the embedding of computation into the fabric of cities has been the rollout of urban control rooms of varying kinds (e.g., security, transport, utilities) capable of generating, processing, analysing and acting on real-time data. Control rooms utilising Supervisory Control and Data Acquisition (SCADA) systems can be traced back to the mid-twentieth century, but have multiplied with the growth of smart urbanism (Luque-Ayala and Marvin, 2016). Early control rooms had a limited focus, usually to monitor and intervene in real-time into the performance of a closed system, for example the operation of an electricity grid. Since the 1980s, the remit of control rooms has expanded to include more open, second-order cybernetic systems in which there are external actors who have their own ability to make decisions and create feedback loops. For example, CCTV centres for monitoring public spaces, wherein control was enacted in part through self-disciplining; or traffic control rooms which mediate the production of space and time, synchronising and optimising the space-time rhythms of vehicular and pedestrian movement and minimising disruption; or emergency management control rooms wherein control is exerted through coordination and direction of resources and personnel (Norris and Armstrong, 1999; Coletta and Kitchin, 2016; Luque-Ayala and Marvin, 2016). In general, control rooms work in the background, out of sight of public view, thus black-boxing the logic and operations of maintaining and regulating urban systems (Luque-Ayala and Marvin, 2016).

Since the late 2000s control rooms have been changing in two respects. First, with the advent of software-mediated systems, control rooms are shifting from human-in-the-loop configurations (where operators make critical decisions on system performance) to more automated forms that enact automated management; that is, they utilise computation to monitor and regulate systems in automated, automatic and autonomous ways, wherein decision-making is ceded to algorithms (Dodge and Kitchin, 2007). Second, a new breed of integrative city control room is being deployed, wherein several systems and their data are corralled into a single centre, with the walls between data and system silos collapsed to enable a more holistic and integrated view of city services and infrastructures.

The example par excellence of an integrated urban control room is the Centro de Operações Prefeitura do Rio in Rio de Janeiro, Brazil (COR). COR is a data-driven city operations centre in which software and human operators continuously monitor the city and it also acts as a coordinated emergency management centre. COR pulls together into a single location real-time data streams from 32 agencies and 12 private concessions (e.g., bus and electricity companies), including traffic and public transport, municipal and utility services, emergency and security services, weather feeds, information generated by employees and the public via social media, as well as administrative and statistical data (Luque-Ayala and Marvin, 2016). Each agency located in COR is autonomous and continues to maintain its own control room, operative systems and response protocols, with the COR providing a site of coordination and horizontal integration (Luque-Ayala and Marvin, 2016). Luque-Ayala and Marvin (2016) contend that this new type of integrated control room produces a new specific form of governmentality by altering the logic of control in four ways. First, as noted the COR draws together several domains and data flows, thus providing a coordinated meta-infrastructure that extends the logic of the control room to the totality of the city. Second, it collapses together control of the everyday (continual maintenance) and the emergency (discontinuous response to specific events), effectively managing the city as a site of perpetual crises. Third, it inverts the usual 'black box' character of control rooms by making its work visible to the public through daily media reports, its website and enabling the public to visit the centre. Critically, the centre is not positioned as a locus of surveillance, policing, discipline and law-enforcement (indeed, it is generally not used for these activities), but as a means to maintain infrastructure performance, minimise disruption to everyday life and share information. Fourth, it enrols the public as a 'citizen sensors' (they supply information to the centre through social/locative media). In the latter case, the public 'engage in the labour of being watched' (Monahan and Mokos, 2013), and are active participants in a system that is beyond their control and modulates their behaviour.

What this discussion highlights is that, while the logics of control articulated by control rooms share similarities, the means by which control is exercised within and mobilised through them is mutable across domain, systems and location, and evolves with new governmental arrangements and technological configurations. Importantly, how power is exercised through urban control rooms varies in three ways. First, there are different practices of control being exerted: intervention, self-disciplining, mediation, coordination, direction, optimisation and co-option. Each is designed to produce particular regulatory outcomes. For example, intervention seeks to directly control and shape an outcome; self-disciplining seeks individuals to self-modulate behaviour in a desired way; optimisation aims to produce an optimal, efficient system; and so on. Second, how systems are configured and operated varies across sites depending on management practices and governance context. Third, the extent of automated management varies with respect to the role of human operators in mediating their work. Some systems, or selected aspects of them, are configured to be human-in-the-loop (algorithms identify issues and suggest solutions but key decisions have to be made by the human operator), some human-on-the-loop (the system is automated but under the oversight of a human operator who can over-ride or take-over the system) and some human-off-the-loop (fully automated) (Coletta and Kitchin, 2016).

City dashboards

City dashboards use visual analytics – dynamic and/or interactive graphics (e.g., gauges, traffic lights, metres, arrows, bar charts, graphs), maps, 3D models and augmented landscapes – to display information about the trends, performance, structure and patterns of cities. Selected data about cities are displayed on a screen using data visualisations, which in many cases are interactive (e.g., selecting, filtering and querying data; zooming in/out, panning and overlaying; changing type of visualisation or simultaneously visualising data in a number of ways). Most data within city dashboards are sampled data generated on a set schedule (e.g., monthly, annually). Increasingly, big data are being incorporated; that is, data that are produced in real-time by the Internet of Things (IoT), automatically produced by sensors and actuators, but also by people through their participation in crowdsourcing and use of locative and social media. In some dashboards data are 'consolidated and arranged on a single screen so the information can be monitored at a glance' (Few, 2006: 34). Here, a city dashboard operates like a car dashboard or plane cockpit display providing critical information in a single view (Gray *et al.*, 2013). Analytical dashboards are more extensive in scope and are hierarchically organised to enable a plethora of interrelated dashboards to be navigated and summary-to-detail exploration within a single system (Dubriwny and Rivards, 2004). Both types of dashboard are used in urban control rooms, but they are also increasingly being displayed in mayor's offices, public buildings, and made accessible to the general public via dedicated websites along with the associated data (see Figure 9.1). In the latter case, citizens are able to use the data to conduct their own analyses and build city apps.

The power and utility of urban dashboards is twofold. First, they act as cognitive tools that improve the user's 'span of control' over a large repository of voluminous, varied and quickly transitioning data (Brath and Peters, 2004). As such, they enable a user to explore the characteristics and structure of datasets and interpret trends without the need for specialist analytics skills (the systems are point and click and require no knowledge of how to produce such graphics). Second, they purport to show in detail and often in real-time the state of play of cities. Urban dashboards seemingly enable users to know the city as it actually is through objective, trustworthy, factual data that can be statistically analysed and visualised to reveal patterns and trends and to assess how it is performing vis-à-vis other places (Kitchin *et al.*, 2015). They supply a rational, neutral, comprehensive and commonsensical media for monitoring and evaluating the effectiveness of urban services and policy, and to learn and manage through measurement. In so doing, dashboards facilitate the notion that it is possible to 'picture the totality of the urban domain', to translate the messiness and complexities of cities into rational, detailed, systematic, ordered forms of knowledge (Mattern, 2014). In other words, they provide a powerful realist epistemology for monitoring and understanding cities, underpinned by an instrumental rationality in which 'hard facts' trump other kinds of knowledge and provide the basis for formulating solutions to urban issues (Kitchin *et al.*, 2015;

Figure 9.1 An at-a-glance (London Data Dashboard) and analytical city dashboard (Dublin Dashboard)

http://citydashboard.org/london/ and www.dublindashboard

Mattern, 2014, 2015). As such, they seemingly provide a neutral and value-free media through which to make sense of, govern and plan a city. And they expand the capacity to govern by extending forms of power/knowledge.

City dashboards are becoming increasingly important mechanisms for evaluating and guiding the work of city administrations and regimes of urban governance, though how they are implemented differs in ethos and form between cities. In general, initiatives fall into two broad camps, which together reveal the inherent tension within schemes between seeking to facilitate accountability, transparency and democracy, and enact forms of discipline, regulation and control (Hezri and Dovers, 2006; de Waal, 2014). In some municipalities, city dashboard initiatives form the bedrock for performance management systems that are used to guide operational practices with respect to specified targets; to provide evidence of the success or failure of schemes, policies, units and personnel; and to guide new strategies, policy and budgeting (Craglia *et al*., 2004; Behn, 2014; Kitchin *et al*., 2015). Since 1999, Baltimore has used a system called CitiStat to implement a balanced scorecard approach to actively monitor the performance of city departments and guide the development of new policies and programmes and then assess the success of their implementation (Behn, 2014). Every week city managers meet to review performance and set new targets for the city as a whole and for each department, and discipline under-achievement (Gullino, 2009). Dozens of other US cities have deployed similar systems. Such an approach is supported by an instrumental rationality that believes that continual monitoring will positively influence the performance, quality and productivity of city staff and services by reshaping behaviours and disciplining and rewarding actions with respect to targets (Hezri and Dovers, 2006).

In other cases, municipalities use city indicator projects and associated dashboards in a more contextual way to provide robust city intelligence, which complements a variety of other information such as staff input, citizen/community feedback, consultancy reports and expert opinion, to help inform policy-making and implementation. In these cases, cities are understood to consist of multiple, complex, interdependent systems that influence each other in often unpredictable ways. Moreover, governance is seen as being complex and multi-level in nature requiring consensus building and cooperation across actors and scales, with the performance of systems and staff not easily reducible to performance metrics and targets. In other words, the city is not a machine that can be fine-tuned and managed through a set of simple data levers (Innes and Booher, 2000). Dashboard information, however, is seen to provide valuable contextual insight that facilitates coordination, integration and interaction across municipality departments and stakeholders by detailing trusted and authoritative datasets for the city and reducing uncertainty and insecurity in decision-making (Van Assche *et al.*, 2010). In other words, dashboards and their data act as a normative and rational bridge between knowledge and policy (Hezri and Dovers, 2006). A long-standing example of a contextual city indicator approach is that employed within Flanders, Belgium, where since the late 1990s a number of cities have employed a common City Monitor for Sustainable Urban Development, consisting of nearly 200 indicators, to provide contextual evidence for policy-making (Van Assche *et al.*, 2010).

Urban power and control

The Dublin Traffic Management and Incident Centre

TMIC provides a single, integrated, 24/7 control room to house the core traffic management systems for monitoring and controlling the road transportation network and traffic flow in the Greater Dublin Area, including dealing with major events and incidents (Figure 9.2). To monitor and regulate the traffic flow the centre uses a network of 380 CCTV cameras, 800 sensors (inductive loops), a small number of Traffic Cams (traffic sensing cameras) used when inductive loops are faulty or the road surface is not suitable for them, a mobile network of approximately 1,000 bus transponders (controllers can also directly contact drivers if needed), phone calls and messages by the public to radio stations and operators, and social media posts. These networks of the Internet of Things and citizen sensors produce a continuous flow of real-time data which are used to dynamically manage the road system.

The core means by which the data are parsed and used to control traffic flow is via the adaptive traffic management system, SCATS. SCATS is an automated and adaptive system whose primary role is to manage the dynamic timing of signal cycles and phases at junctions for vehicles, cycles and pedestrians in order to ensure the optimal flow, minimise congestion and accidents, and manage incidents. The system is adaptive in the sense that it automatically calibrates the cycles and phases dependent on a set of programmed rules and the flow, speed and density of traffic for each lane of traffic in previous cycles and phases. For example, the number of cars and the gaps between them as detected by the inductive loops denotes if a phase was too short or long, with the timing of the next phase recalculated automatically by the system. Public buses benefit from prioritisation, so as they approach a junction the phasing will alter to accommodate their passage. By pressing a pedestrian crossing button at junction, people produce a temporary break in the phasing, closing down the main phase in order to run the pedestrian phase. Cycles are set to last a minimum of 40 seconds to a maximum 130 seconds, but in practice they rarely exceed 80 seconds or go below 60 seconds. This calculation is based on the pragmatic evaluation that the waiting time for a pedestrian crossing above 80 seconds would be too long. Given that alterations in cycles

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Figure 9.2 A view from a controller's desk in the Dublin traffic control room
Author photo

and phases flux, altering traffic flows across the system, changes in one location can sometimes produce congestion elsewhere, and the system seeks to minimise such disruption by balancing competing demands across junctions.

By monitoring patterns over time, the TMIC staff can configure the setting of SCATS to take into account whether it is a weekday or weekend, as well as seasonal/daily rhythms and when schools are closed. In addition, operators can intervene and override the present or original SCATS settings. In this sense, SCATS is a human-on-the-loop system, wherein automation is used monitor and regulate traffic flow but operators oversee and can manually override its work. To oversee SCATs, a controller is presented with a dashboard-like interface (Figure 9.3). The right hand part of the screen displays a junction, the various traffic lanes and their phases, and the left hand part the length of time for each phase. Interventions are circumscribed by the initial configuration of the system by Intelligent Transportation System staff, who in turn refer to the Traffic Signs Manual by the National Roads Authority that sets rules on the minimum and maximum times for phases. If, for example, operators try to go below the minimum safety times for green or red time on a different phase, SCATS will automatically override the modification attempt with the original configuration.

As well as directly altering the phasing of junctions and the rhythms of traffic flow, much of the data utilised in the traffic control room is shared with the public via a number of channels, enabling people to see and interpret the data themselves and self-regulate their interactions with the traffic system and to manage time-based decisions for journey planning.

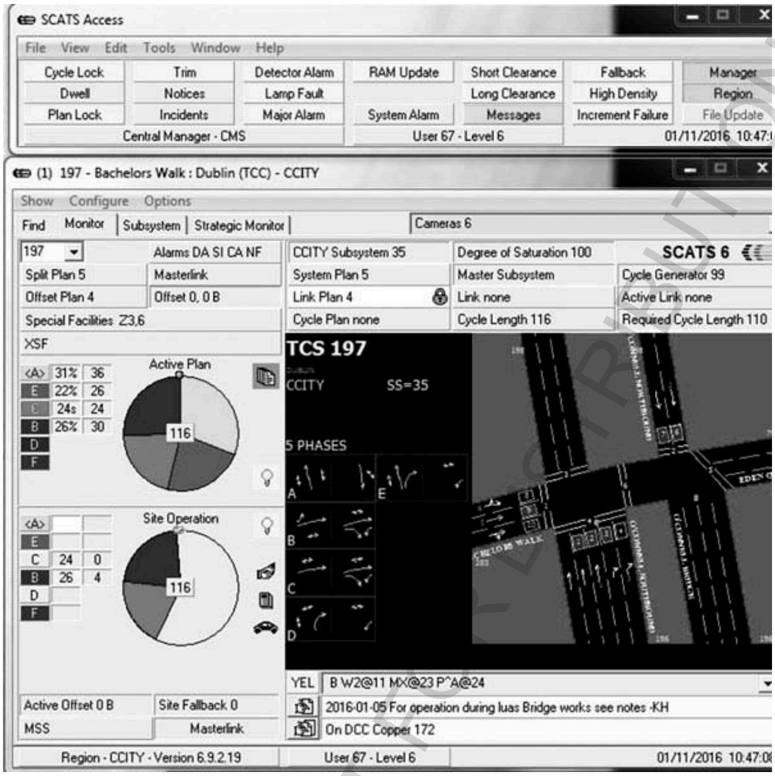

Figure 9.3 The SCATS interface
TMIC screenshot

For example, real-time information about the expected arrival time of buses and trams are shared via smartphone apps, websites and on-street dynamic signs. Details of congestion and traffic accidents are shared via radio bulletins (one of the desks in the control room is reserved for an AA Roadwatch operator who communicates traffic news to radio stations throughout the day, and three desks host Dublin City FM's live broadcast of traffic news and music between 7 and 10 am and 4 and 7 pm, Monday to Friday (www.dublincityfm.ie/). These broadcasts inform and pacify travellers and enable them to seek alternative routes. Data from the systems are openly shared via Dublinked (the city's open data portal) and displayed in the Dublin Dashboard.

SCATS is a second-order cybernetic system that enacts a human-on-the-loop form of automated management to dynamically modulate the movement of people while also enrolling them as citizen sensors. At present, the Dublin TMIC is not used for routine surveillance or policing. While the centre pulls together data from a number of different systems, including from citizens, and one desk is reserved for Gardai (police) use, the centre does not generate or store indexical data (e.g., it does not employ automatic number plate recognition cameras), nor does it record video footage. Nor is it responsible for speed, red light or bus lane cameras. That said, the Gardai do have their own access to the camera network, which they use for policing. Moreover, the centre can be used for managing major events and emergencies. As Monahan (2007) details, traffic control rooms are particularly susceptible to control creep, with the purpose of managing traffic flow being extended to include routine surveillance, policing and security work, and the data generated shared with other state agencies. With this control creep the governmentality enacted by traffic control rooms shifts. In addition, he notes that while traffic control rooms are portrayed as socially and political neutral and impartial in how they manage traffic, they nonetheless support certain values and socially sort the users of city space, 'valorizing certain mobilities over others, while normalizing unequal experiences of space' (Monahan, 2007: 373). As such, intelligent transport systems sustain 'ongoing neoliberal development patterns by emphasizing "pipes" over places, maximizing the flow of privately owned vehicles through those pipes' (385), and privileging the support for certain mobilities over others (private over public transportation, driving over walking or bicycling).

The Dublin Dashboard

The Dublin Dashboard (www.dublindashboard.ie, Figure 9.1) is an extensive, open, analytical dashboard launched in September 2014. It provides citizens, planners, policy-makers and companies with an extensive set of data and interactive data visualisations about Dublin City, including real-time information, indicator trends, inter and intra-urban benchmarking, interactive maps, location-based services, a means to directly report issues to city authorities, and links to city apps. The data used in the dashboard are open and available for anyone else to build their own apps. Like the London dashboard in Figure 9.1, the Dublin Dashboard was initiated as a university research project, with the aim of exploring the praxes and politics of developing such a dashboard (Kitchin *et al.*, 2016). However, most urban dashboards are initiated and produced internally or by a third-party supplier (either as a bespoke product or using a template solution such as Socrata) (Kitchin *et al.*, 2015).

Shortly after initiation, the project started to work with Dublin City Council, with city officials supplying data and providing feedback on its development. Although the dashboard is presented as a stable, authoritative and technical assemblage of networked infrastructure, hardware, operating systems, assorted software and data, achieved through neutral, objective processes of scientific conception, engineering and coding, it is also thoroughly social and political. Indeed, it is a complex socio-technical assemblage of actors (e.g., university researchers, city officials, other stakeholders) and actants (e.g., data, software, servers, standards) that work materially and discursively within a set of social and economic constraints, existing technologies and systems, and power geometries to assemble, produce and maintain the system (Kitchin *et al.*, 2016). During development, ideas and choices concerning the aims, principals and technical approach were debated, refined, rescinded, reinstated and revisioned. For example, there were debates concerning what indicators to include and how they should be presented, with the city officials conscious of the potential media and political messaging such data might produce. As such, whilst the narrative spun by companies, and often also by city management, suggests that the transition to a smart city is a smooth path of rollout and integration, the reality is a set of iterative processes of debate and compromise.

Over time, the dashboard has continued to evolve and mutate in terms of the data included, the tools and modules produced, and design interface. In its second phase of development, post-2016 it has been completed revamped to be entirely open source (open code and open data) and cater for different levels of data literacy. What this contingency and relationality means is that power and control are never fixed in either the creation or ongoing operation of city dashboards (Kitchin *et al.*, 2016). That said, initial design does provide

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a certain degree of path dependency in how the dashboard is organised and its functionality, and how it develops over time. As such, of particular importance to the logic of power and control in the development and use of the Dublin Dashboard were its aims and principles.

Initially, the aim of the site was to provide a contextual, rather than a performance-management, dashboard for the city. The underlying principles related to its development were: there would be no closed modules, with all of the visualisations on the site accessible to everyone; all of the data used on the site would be open in nature, enabling others to build their own apps; as much data as possible, regardless of source or type, would be made available through the site; where possible it would use open source tools; existing resources and apps would be used if they did a good job to remove duplication of effort; the site would be easy to use, with users requiring no mapping or graphing skills; and the site would be interactive allowing users to explore the data.

The Dublin Dashboard then sought to enact an approach that aligned with the principles of open government and the open data movement aimed at producing transparency, participation, empowerment, accountability and evidence-informed decision- and policy-making. However, it did not embrace targets or performance-driven metrics designed to implement a form of city managerialism-by-data. This was one area of negotiation between the research team and the local authority. However, in the absence of already established targets, the lack of mechanisms to guide and react to performance vis-à-vis such targets, and the political nature of the project arbitrarily imposing targets, it became a moot point. The logic of the system was then neither discipline nor control-orientated in a direct way, but rather sought to provide evidence for citizens and city workers with respect to key aspects of everyday life. Nonetheless, the ability to make sense of, mobilise and act on the data presented through the dashboard varies across individuals and organisations, and the data are still used to assess the performance of the city administration and to pressure for reforms and change through political and media campaigns. Moreover, because the data tools are used to shape policy formulation and to justify and underpin modes of governmentality, they inevitably shape and reproduce how people are governed. For all city dashboards, although the updating of the data and visualisation tools can be automated, any control actions are usually human-in-the-loop in nature. That is, the translation of information into knowledge and action, and forms of governance and governmentality, are performed by people rather than algorithms.

Conclusion

There is little doubt that smart city technologies are changing urban governmentality and governance. At a broad level, the embedding of computation into the fabric of cities and its use to manage city services and infrastructures are shifting governmentality from disciplinary forms to those of social control. Here, rather than governmentality concentrating on moulding subjects and restricting action within spatial enclosures, it seeks to modulate affects and channel action across space. However, as our discussion of urban control rooms and city dashboards reveals, this transformation in governmentality is uneven and diversely constituted. Indeed, there is much variety in the configuration and deployment of socio-technical assemblages – even within particular technological domains such city dashboards and control rooms – and in their logics of control, tactics and operational techniques. For example, systems vary with the extent to which they implement forms of automated management (with humans in-, on-, off-the-loop) and in how they seek to enact governmentality: through modes of surveillance and discipline or capture and control; through systems that are 'black-boxed' or transparent; and through regulatory techniques such as coercion, co-option, self-disciplining, punish, modulation, intervention, mediation, coordination, direction and optimisation.

The logics of control articulated by smart city technologies are diverse and mutable across domain, system, location and context. In a city with a range of smart city systems, several related and overlapping forms of governmentality can be enacted and promoted by different entities and be at work at the same time. Both the Dublin TMIC and the Dublin Dashboard pull together and integrate a range of urban data. Both seek to enrol citizen sensors to crowdsource additional data, and both openly share some of their underlying data with the public. The Dublin TMIC seeks to produce a continuous modulation in the flow of traffic using SCATS, a second-order cybernetic system of control, and has a human-on-the-loop configuration. It aims to optimise the performance of the road network, minimising congestion and maximising flow and speed of movement. In contrast, the Dublin Dashboard is rooted in an open data/government ethos and set of principles designed to promote openness, transparency and contextually based, evidence-informed policy-making, and it is very much a human-in-the-loop configuration with regards to action. This diversity in ethos, purpose and logics of control multiplies across the range of smart city technologies deployed in a city.

At any one time then, there are varieties of governmentalities at work in the neoliberal smart city (Ong, 2006). However, heeding caution from Brenner et al. (2010) about overstating the diversity and mutability of governmentality and divorcing its forms from their wider context, it is important, we believe, to consider a number of related questions. These include: How do smart city technologies and initiatives and their associated governmentality and logics of control fit together? Do they work in concert or in opposition to one another? How do they dovetail with other assemblages and practices of governance? Do they work within, reproduce and evolve the wider political economy and regulatory context?

What is required then is for the governmentalities of specific smart city assemblages to be unpacked and to chart how they work in collaborative concert (see Vanolo, 2014; March and Ribera-Fumaz, 2016; Datta, 2018; Wiig, 2018). This needs to be complemented with a mapping in detail of the wider overlapping governmentalities of the smart city, how initiatives interlink and work together to legitimise and (re)produce technocratic forms of governance, and how the practices and governmentalities of smart city endeavours coalesce with and extend those framed and enacted through other means (Shelton *et al.*, 2015; Karvonen *et al.*, 2018; Cardullo *et al.*, 2019). Such a mapping, we believe, needs critical attention if we are to understand the logics of control of smart cities, how they work to produce particular formulations of the neoliberal city, and how we might envisage and create a different kind of smart city.

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