The maintenance of urban circulation: An operational logic of infrastructural control

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Abstract

This paper examines the increased visibility of urban infrastructures occurring through a close coupling of information technologies and the selective integration of urban services. It asks how circulatory flow is managed in the contemporary city, by focusing on the emergence of new forms of governmentality associated with 'smart' technologies. Drawing on Foucault's governmentality, and based on a case study of Rio de Janeiro's Operations Centre (COR), the paper argues that new understandings of the city are being developed, representing a new mode of urban infrastructure based on the partial and selective rebundling of splintered networks and fragmented urban space. The COR operates through a 'un-black boxing' of urban infrastructures, where the extension of control room logics to the totality of the city points to their fragility and the continuous effort involved in their operational accomplishment. It also functions through a collapse in relations of control—of the everyday and the emergency—, which, enabled by the incorporation of the public in operational control, further raise public awareness of urban infrastructures. These characteristics point to a specific form of urban governmentality based on the operationalisation of infrastructural flows and the development of novel ways of seeing and engaging with the city.

1. Introduction

In 2011 Rio de Janeiro opened an operations centre known as the *Centro de Operações Rio* (COR), a metropolitan scale control room aimed at providing integration across a multiplicity of public and private organisations in charge of managing urban infrastructures, delivering key local services and providing for emergency response. Rio's COR, remarkable for its dominant role within public imagination, has been ubiquitously showcased by the media and technology corporates as an exemplar 'smart city' initiative (see New York Times, 2012). Its operations have generated a significant increase in the visibility of urban infrastructures, a function of a close coupling between networked infrastructures and information technologies alongside the establishment of new ways of seeing the city and its infrastructures through media platforms. By examining in detail the functioning of the COR and its possible implications for the configuration of urban governmentalities, and drawing on a Foucauldian unpacking of circulation as a "key instrument and target of governing processes" (Aradau and Blanke, 2010: 45), this paper asks how circulatory flow is managed in the contemporary city. The paper focuses on the emergence of new forms of governmentality associated with 'smart' technologies (Braun, 2014; Gabrys, 2014), examining a developing form of circulatory control through information technologies.

The COR "operates 24 hours a day and 7 days a week, interconnecting the information of several municipal systems for visualisation, monitoring, analysis and response in real time" (Prefeitura Rio de Janeiro, 2011: 14). The idea dates back to April 2010, when the State of Rio experienced a traumatic rain event that resulted in widespread flooding,

hundreds of landslides, 15,000 homeless families and the loss of over 200 lives. Rio de Janeiro, the State's capital, was significantly affected. The city's main roads were flooded, public transport collapsed, power, gas, and water supplies disrupted and commercial activity paralyzed. Shortly afterwards the city's mayor, determined to put in place the required tools to increase the city's ability to respond to emergencies, enlisted IBM in envisioning a facility capable of providing rapid responses to urban disruptions whilst constantly feeding information—to other public agencies as well as to the public—on the state of the city. The COR was designed to function both as an operations centre (running the city's everyday) and an emergency response centre, two processes which, according to an IBM engineer involved, utilise the "the same approach and the same actors, players and technologies" (Interview, 2014). It overcomes issues of institutional isolation through a digital architecture and physical co-location that facilitates communication whilst maintaining the specialised knowledge and experience that exists within each agency. Whilst each agency remains autonomous, maintains its own control room, operative systems and response protocols, the COR provides both the computational capacity and physical location where horizontal integration of urban flow maintenance can be managed and coordinated. In its main operations room, formally known as the Control Room (Figure 1), staff members from different agencies share and access in real time a broad range of information about the state of the city, whilst dispatching responses and allocating resources. Here, through a mapping platform built over systems developed by Google Enterprise, the COR visualises key resources and disruptive events in real time, from vehicle collisions to power outages. Its screens are constantly exposing the city and its operations, through video images captured by over 800 cameras and maps displaying geo-referenced urban data (e.g.

weather patterns, public transport movements and even the location of each of the city's municipal guards).

The COR extends a control room logic to the totality of the city and establishes a form of governing that rests on the incorporation of the public as a functional element of urban infrastructures. We argue that, through a renewed emphasis on organisational integration, the collapse of the everyday and the emergency and the use of a variety of digital and visual techniques for engaging the public within infrastructural operations, the city's infrastructures gain new forms of transparency, increasingly appearing un-black boxed and open to the public. Such novel infrastructural configuration problematizes common understandings of urban infrastructures, traditionally seen as black boxed, splintered and taken for granted (Hughes, 1983; Graham and Marvin, 2001). The paper shows that this emerging mode of control is focused on maintaining urban circulations and flows, placing an emphasis on the operationalisation of the urban. Within COR's operations, audio-visual equipment for monitoring and control, including cameras and sound alarms, alongside digital techniques for mapping and visualising, create an illusion of total control but also the potential for new understandings of the city. The public plays a central role in maintaining such circulations, achieved through the use of traditional media (e.g. radio and TV) and new forms of engagement via smartphone apps and social media—resulting in new forms of visualisation *of* and *through* urban infrastructures.

Figure 1: The COR's Control Room. Image copyright: the authors

The empirical material, collected during April and May 2014, is the result of interviews with COR directives and other personnel working with public and private organisations involved in the centre's design and implementation, as well as site visits and TV broadcasts involving the COR. The focus is on the control room and the representation of the city that emerges through the interaction between the control room and the media, and therefore the methodological approach was not designed to capture the public's response to the claimed transformations in forms of urban governmentality. The paper is divided in four sections. Section 2 introduces notions of governmentality, opening possibilities for an understanding of the COR as an apparatus of security geared

towards the maintenance of urban circulations. Section 3 focuses on the COR's everyday, describing how it functions through operational rebundling and discussing how it engages with media outlets, opening novel ways of seeing the city. Section 4 focuses on the COR as a device for emergency response, further elaborating on how emergency is institutionalised. Section 5 concludes by discussing the key contribution of the paper.

Examining the maintenance of circulation in a city like Rio de Janeiro inevitably requires engaging with empirical and academic debates around the securitization of the urban. In a city whose contemporary politics have been shaped by crime and inequality (Kleiman, 2001), local elections position issues of violence and security as a priority. The COR's history is not exclusively related to the management of emergencies, but also the need to secure and manage mega-events, particularly the 2014 World Cup and the 2016 Olympics. In Rio and elsewhere, urban security strategies have found a promising development platform in the new infrastructures of urban control developed for mega sporting events (Cardoso de Vasconcelos, 2013), establishing "temporary regimes of extra-legal governance that permanently transform [the city's] socio-space" (Gaffney, 2010: 7; see also Coaffee, 2015; Graham, 2011; Fussey and Klauser, 2015). Drawing on an extensive body of work around surveillance and coercion, critical scholars have examined the role of circulation in such forms of securitising the urban, pointing to how "people and objects are mobilised, monitored and filtered between fortified places" (Fussey, 2015: 214; Klauser, 2013; 2015) and identifying the ways in which such processes alter both the physical configuration of space as well as how the public perceives it (Coaffee, 2013). Although the COR was developed in this context we argue in this paper that its form of response cannot be simply located within the analytical domains of coercion and surveillance. Drawing on a Foucauldian interpretation of

power as creative, enabling and productive of subjects, meanings and interventions (Patton, 1998; Miller and Rose, 2008), we argue that the COR operates in a governmental fashion through enabling freedoms rather than imposing constraints. The municipal nature of the COR bounds its remit to urban management; despite minor policing functions carried out in coordination with the city's Municipal Guard (responsible for, amongst others, parking and traffic management, environmental protection and tourism support), its primary function stands away from issues of crime prevention and policing, two functions which—under the Brazilian Constitution—rest at federal and state rather than municipal levels.[1] The COR therefore illustrates a broader understanding of security as "the range of technologies and power/knowledge epistemologies which regulate freedom as contingency through the principle of economy" (Dillon, 2015: 48).

2. Urban control and the government of infrastructure

Governing the contemporary world appears increasingly as an urban endeavour (Magnusson, 2011; Braun, 2014). Key global processes rapidly transforming the world, such as climate change, economic crisis and the rapid advance of digital technologies, find significant expressions in cities. In this uncertain world new modes of governance incorporate crisis as ubiquitous and disaster as inevitable, with the city seen as a primary site of experimentation and intervention (Hodson and Marvin, 2009; Wakefield

[1] In order to guarantee security—in its more traditional sense—for the 2014 World Cup, state and federal governments established another control room, the Integrated Centre for Command and Control (CICC). This integrates a variety of state and federal policing agencies, including the Armed Forces, Civil Police and Military Police. While the CICC and the COR exchange information and use similar technological platforms, arguably the CICC operates primarily within the domains of coercion and surveillance whilst the COR operates mostly in a governmental fashion.

and Braun, 2014). We argue that the COR illustrates such emerging modes of governance, where governing occurs not only thought the material (infrastructural) capacities of the city but also through the constitution of novel ways of seeing and expanding such capacities. Here we build three steps in our analysis. First, a broader conceptual framing around the relationship between governing, technology and the city (Otter, 2007; Joyce, 2003), alongside recent attempts to examine emerging urban governmentalities and the constitution of the milieu at the crossroads of technology and crisis (Braun, 2014; Gabrys, 2014; O'Grady, 2013; Halpern et al., 2013). Second, geographical and socio-technical approaches around networked infrastructures and infrastructural black boxing (Graham and Marvin, 2001; Graham, 2010; Corsín Jiménez, 2014). Thirdly, approaches analysing the functions and operations of control rooms, and how these establish ways of seeing the urban (Gordon, 2012).

Governing the city through infrastructure

The government of the city features as a central concern in the work of Foucault, who frames the problem of the city as one of circulation. It's governing, by enabling circulations, establishes a form of 'laisse faire': it lets things happen (Foucault, 2007). This government is to be achieved through an apparatus of security: a relational ensemble of discourses, institutions, regulations, technological objects and forms of knowledge arranged in particular ways in response to "*urgent needs"* (Foucault, 1980: 195, original emphasis; see also Pløger, 2008). In contrast with the prohibitive nature of the law and the prescriptive nature of discipline, security relies on natural and material givens, or a reality of fluctuations, "so that, by connecting up with the very reality of these fluctuations, and by establishing a series of connections with other elements of

reality, the phenomenon is gradually compensated for, checked, finally limited, and… cancelled out" (Foucault, 2007: 37). By signalling to the extent to which the governing activity relies on freedom Foucault points to how, beyond the operationalisation of a liberal ideology, what is at stake is a technology of power.

Given its emphasis on the mechanisms by which governing occurs, we find Foucault's notion of governmentality particularly useful for unpacking the manifold transformations that characterise the interface between digital and urban worlds. Drawing on a concern with how thought becomes embedded in technical means, governmentality directs attention to a form of governing "through the freedom or capacities of the governed" (Dean, 2010: 23). It provides an understanding of the ways by which the transformation of regimes for urban control, exemplified by the COR, involve new ways of governing infrastructures and population through them. It also enables an understanding of how this transformation operates through specific visual and material means, introducing subjects and subjectivities whilst re-defining spatial and political relationships between the agents involved.

Drawing on governmentality frameworks, Otter (2007) and Joyce (2003) have explored the relationship between governing, technological machines and the city. Otter criticises traditional takes on governmentality (e.g. Dean, 2010; Miller and Rose, 2008) for focusing on bureaucratic and discursive governmental techniques, silencing "the brute materiality of technology" (Otter, 2007: 578). He suggests that technological systems are endowed with an agency of their own and play a key role in allowing liberal subjects to be conducted by shaping how they conduct their own conduct. This materiality carries a political significance, enabling a "government *through* and *by* technology" (Otter, 2007: 578, original emphasis). Here, multiple machines and socio-technical networks—from roads and sewers to electricity grids and gas networks—secure in a

dispersed way and operate as a way of materialising an indirect mode of rule. In the city, material infrastructures operate as techno-social solutions of a political nature. Such politics is enhanced precisely by the fact that the solution is implemented as 'technical', therefore external to political domains (Joyce, 2003).

Black boxing networked infrastructures

The COR can be understood as a form of meta-infrastructure—a capacity that coordinates selected control functions of diverse networked infrastructures. Urban infrastructure networks—such as energy, water, sewerage, transport, waste and telecommunication systems—are considered to be the key physical and technological assets of cities. They "provide the technological links that make the very notion of a modern city possible", enable exchanges and dynamic relationships between different actors, and represent capital and knowledge embedded in the city (Graham and Marvin, 2001: 13). They are not limited to material technological devices, neither are free from political, cultural and symbolic representations and implications. Operating as both political and symbolic devices, they support visions and ideals of the future (Nye, 1999).

Despite the significant social and political implications of infrastructures, they involve powerful images of stability that allow them to be taken for granted, appearing to be "immanent, universal, [and] unproblematic" (Graham and Marvin, 2001: 21; see also Hughes, 1983). Infrastructures possess an invisibility that leads them to quietly support the task at hand (Leigh-Star, 1999). Such invisibility is referred to as 'black boxing', defined as a "(temporary) stability, so much so that the controversies surrounding their adoption have to a large extent been erased" (Hinchliffe, 1996: 665). Given this 'black boxed' nature, infrastructures often "disappear almost by definition. The easier they are

to use… [and] the bigger they are, the harder they are to see" (Bowker and Star, 2000: 33). Yet, for the purpose of this paper, there are two important caveats to be made. The ubiquitous invisibility of infrastructure is shattered upon breakdown, revealing the fragility and precarious achievement of stabilised infrastructure (Leigh-Star, 1999, Graham, 2010). Moreover, in a city like Rio de Janeiro, in the global South, a large segment of the population experience infrastructures in a permanent state of disrepair and improvisation, providing the context for fragmented urban fabrics (Coutard, 2008, Graham and Thrift, 2007; McFarlane, 2010). Whilst in everyday life infrastructure usually appears stable and black boxed, there is one urban site where infrastructure always appears at a point of breakdown: the control room.

Control rooms and the maintenance of urban circulation

Besides operating as a macro-level urban infrastructure, the COR is also a control room. Like other control rooms, it is a key site that enables the city's infrastructural life by securing urban flows and maintaining the city's circulations. Thanks to their continuous work in preventing breakdown, responding to disruption and overcoming interruption, control rooms play a key role in the achievement of infrastructural 'black boxing', and through this, "the continuation of what has become normal" (Gordon et al., 2014: 10). Like infrastructure, they tend to be invisible: they are enclosed and hidden environments, often subject to extreme security given their importance as control foci for network infrastructures (Coaffee et al., 2009). The literature on control rooms identifies two broad types: those established for normal operations—for the management of the everyday—and those, usually temporal, established for exceptional operations—for the management of the emergency (Gordon, 2012). Despite the

primary role of both of these for the functioning of infrastructures, control rooms have been remarkably absent from academic literature on networked urban infrastructures (for an exception see Silvast, 2013). Instead socio-technical analyses of control rooms are grounded in two largely disconnected fields: first surveillance and criminology studies, where the control room is seen as a site from where specific ways of seeing the city are constituted (Boyne, 2000; Graham, 1998; Monahan, 2007; Norris and McCahill, 2006; for an analysis specific to Rio de Janeiro see Cardoso de Vasconcelos, 2012); second as a node of coordination, where the spatial and temporal gap between human and material participants is filled by technology (Suchman, 1995; Ikeya, 2003; Lundberg and Asplund, 2011).

Developing a broader understanding of agency within control rooms, Gordon points to their work as "an ongoing yet situated practical accomplishment" (2012: 119). Capacity to act is not limited to individual (staff members) or technology, but achieved as a dispersed and relational effect involving human and nonhuman agents. Thus, the accomplishments of the control room require continuous effort; from the perspective of the control room, infrastructure is not invisible or stable, but rather transparent, unstable and always at a point of breakdown (Gordon et al., 2014). But what happens when a conventionally hidden control room is opened to the city and reconfigured as a metropolitan object capacity-capability for the management of the city's infrastructure?

3. Rio's COR: governing the city's everyday

Although cities' infrastructures are usually controlled through a complex patchwork of separate control rooms at a range of scales, the COR is unique in that it brings the

horizontal control of these networked infrastructures together in an integrated centre. Technologically and institutionally separate networked infrastructures are brought together within a single domain of control, echoing what Collier and Lakoff (2014) have identified as a 'system of systems' aimed at reducing risk and vulnerability. Such an emerging mode of infrastructural control is characterised by an organisational and material re-bundling, where ICT platforms and visualisation of spatial data play an important integrative role. Broadcasting an image of an integrated city, the COR not only presents infrastructural operations to the public but also engages the public as a key component of the city's infrastructural operations. This section provides an overview of the everyday functioning of the COR, by focusing on three of its operational domains: its integrative capacity, its relationship with the media and its interaction with the public via new media technologies.

Operational rebundling towards flow maintenance

The COR's key abilities are predicated on its capacity to provide horizontal integration and coordination of those selected aspects of infrastructure control concerned with the maintenance of circulation under normal and emergency conditions. This is achieved through the work of over 400 staff members working 24/7, representing 32 municipal agencies (including waste collection, transport, health, social assistance, Civil Defence and the city's meteorological monitoring agency), 12 private concessions (including the bus companies as well as *Light*, the privately owned company in charge of supplying electricity to the city), and a selected number of state level agencies. "We focus on those organizations that are directly linked with citizen's wellbeing on an everyday basis", explains a COR director (Interview, 2014). The municipal agency that has the largest

number of representatives is the Transport Department (*SMTR*), and their cameras lead to the COR's primary workload. As explained by a director, "since the major bottleneck of this city on an everyday basis is traffic, staff works mostly with the images of the cameras, showing the streets" (Interview 2014). Traffic flows during large events such as the World Cup are a priority, with COR staff preparing in advance routes for the different sport delegations, determining closure points for the purpose of safety and drawing alternative routes for non-essential traffic. But these are not the only flows and resources that are visualised and monitored—energy provision, waste collection, and even social services are also mapped in real time. "We show the work of agencies, agents and people. For us, for example, during New Year's Eve is important to know where all the waste collection trucks are located, working all over the city, so that the city is clean at the end of the celebration" explains a staff member. He continues, "I can visualize the electricity transformers of *Light* and identify where there are power cuts in the city, which is crucial for the COR" (Interview, 2014).

For the COR, integrating a large number of agencies means accessing a greater amount of information, the key currency that enables its operations. Integration occurs through organizational and institutional arrangements as well as spatial and visual arrangements and information flows. This takes the form of spatial data (geo-referenced location points to be mapped on a common GIS platform) and image exchange. "The [toll-road] concessions send us their images, and … members of the COR analyse those images on a constant basis" explains a COR executive (Interview, 2014). Physical co-location plays an important role in sharing information—three times a day all agencies represented at the COR have a 15 minute meeting where representatives from each agency report on any relevant incidents and on the actions being taken towards resolution. "Nothing substitutes direct physical contact", argues the director of

the city's Civil Defence (Interview, 2014). The COR employs directly a group of coordinators who establish the required links between different agencies, monitor and follow progress on incident response, and when needed, put pressure on agencies to speed up response time. In describing their role, the Director of Operations points to their previous corporate sector experience with logistical operations and control: "they come from the private sector… They are highly trained, with experience in operating airports and aviation companies, and who are now operating cities" (Interview, 2014).

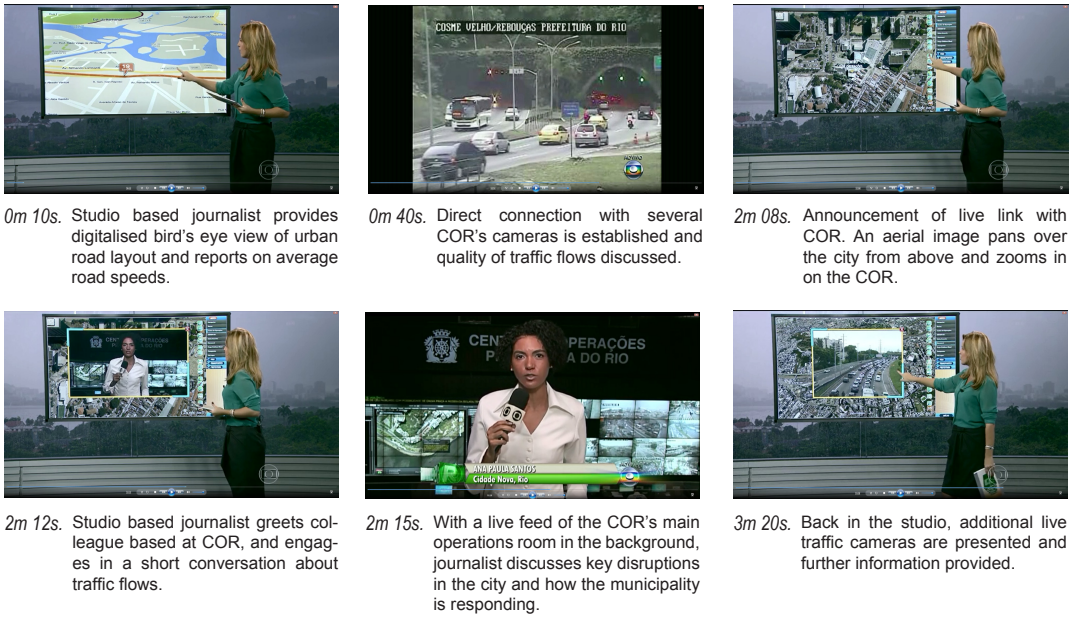
Infrastructural journalism in the everyday

Traditionally, the role of control rooms in the management and organisation of infrastructural systems is not visible to the public—except in an emergency or following disruption (Graham, 2010). Yet, inside a control room, the fragility and potential instability of the infrastructure network is fully visible to the operators and a constant source of pre-occupation (Gordon, 2012). The work of maintenance, control and restabilisation is largely lost to the users of infrastructure. Establishing a sharp contrast, the COR is highly visible within the Rio context. The media plays a critical role in positioning the COR within the city's collective imagination, directing the citizen's gaze to urban infrastructures. Both the precariousness and potential instability of the city's infrastructure is laid bare for the public to see on TV screens, media reporting and social media. Rather than being invisible, the COR appears to operate as a key passage point for understanding the city, opening its infrastructures to the public. Seeing and acting as a command and control room, through its pervasive role in media representations of the city, the COR becomes a critical producer and communicator of knowledge about the city.

Hosting the media is part of the COR's strategy to establish a continuous two-way communication with the public, in line with broader municipal narratives praising transparency in local government. In the words of one of the COR's directors, "this is a form of transparency in public service, and an explicit purpose of the mayor himself. Everything here is done in a very transparent way, with the media reporting from here 24 hours a day" (Interview, 2014). Such understanding of transparency is embedded within the physical design of the building, with the pressroom located on an open balcony right above and with a full view of the Control Room. It is fitted with 14 desk stations that are in permanent use by radio and TV journalists who constantly report on the state of the city and its infrastructure, whilst also, at times, providing the COR with additional sources of information.

A brief account of a typical morning at the *TV Globo Rio de Janeiro* channel provides a snapshot of the COR's interaction with the media. Every weekday during the morning rush hour Globo TV, Brazil's largest TV network, broadcasts directly from the COR. Embedded within a well know breakfast show called Good Morning Brazil (*Bom Dia Brasil*), Globo TV transmits periodic 4 minute live segments of news with a focus on urban issues. The broadcast of the relay between the TV studios and the COR occurs in a highly performative manner through the use of a variety of visual techniques. Studio based journalists, reporting in front of a TV screen displaying maps and satellite images of the city whilst showcasing the issues discussed, announce a live link to the COR at moments when additional in depth and up-to-date information is required. The announcement of such transmission relay starts with an aerial image of Rio de Janeiro, providing a bird's eye view of the city whilst rapidly zooming-in on the COR. "With our map, let's go there, to the Operations Centre, to establish contact with [our journalist]

there", says the studio-based journalist only seconds before one stationed at the COR takes over (Figure 2).



0m 10s. Studio based journalist provides digitalised bird's eye view of urban road layout and reports on average road speeds.

0m 40s. Direct connection with several COR's cameras is established and quality of traffic flows discussed.

2m 08s. Announcement of live link with COR. An aerial image pans over the city from above and zooms in on the COR.

2m 12s. Studio based journalist greets colleague based at COR, and engages in a short conversation about traffic flows.

2m 15s. With a live feed of the COR's main operations room in the background, journalist discusses key disruptions in the city and how the municipality is responding.

3m 20s. Back in the studio, additional live traffic cameras are presented and further information provided.

Figure 2: screenshots of a typical 4 minute morning broadcast linking Globo TV studios with the COR.

These daily broadcasts focus on the city's weather, transport conditions, emergencies or other events likely to disrupt daily commutes or other urban flows. High-level ranking municipal officers are interviewed to discuss various urban events, from changes in public transport charges to a waste collection strike. Jointly, the COR and the media provides them with a chance to explain the measures the municipality is taking in response to disruptions: a visible platform to communicate municipal actions towards restoring circulation. Reporting directly from the COR's pressroom, using the screens of the COR as background, Globo TV provides viewers with an insight on the heart of the

city's operations. Through engaging with the COR, these live broadcasts about the city and its flows capture a multiplicity of urban sites, as journalists, enjoying direct access to the COR's data, flick between the many traffic cameras or rain gauges which the COR integrates. During TV transmissions, the relay between studios and the COR draws on satellite imagery and bird's eye views—on ways of seeing from above, intuitively stressing the possibility of an all-round understanding of the city. This viewpoint frames the relationship between the COR and the public eye, an Apollonian gaze which, in the context of smart digital technologies, instils an illusion of total control (Cosgrove, 2003; see also Kingsbury and Jones, 2009).

Visibility of, and through, infrastructure becomes embedded in the way the Rio municipality claims a principle of transparency and a mission around immediate response. The COR, reaffirming a mode of governing through infrastructure and exemplifying how technology and design play a central role in emerging modes of urban governance (Wakefield and Braun, 2014), puts in practice a way of governing through visual domains (Dean, 2010; Otter, 2008). As a control room linked to both urban infrastructures and the media, multiple infrastructure sites are made visible within the everyday, and such visibility is expected to generate particular reactions—or conducts—in the public: changes in traffic routes, preparations for emergency response, avoidance of sectors of the city, or simply patience until services are re-established. In making infrastructure visible and pointing to its weaknesses and breakdowns—congested roads, sites of accidents, power outages, weather incidents—the COR operates in a governmental fashion, "forming an internal feedback loop within the apparatus itself" (Braun, 2014: 53). Authorities are both surveyor and surveyed, as the public is given the opportunity to experience the city through the COR: "the COR is the eyes of the population; for everything that happens here [in the city] we must give the

best possible response in the quickest possible way", explains a COR director (Interview, 2014). Whilst the COR's limited emphasis on policing allows it to embrace a discourse on transparency in its management of the everyday, its integrated use of information allows it to construct itself as the very vehicle for transparency and accountability; information is not only a path towards operational response, but crucial in explaining and justifying disruption. Yet, as discussed by Dillon (2015: 40), "the more radically transparent modern rulers and the ruled become to demographic and digital knowledge, the more politically opaque does the world become to rulers and the ruled alike". In the material reality of Rio several urban operations still remain invisible, working far from the COR's control capabilities and the public's eye, from the problematic sewer networks of Rio to the new cable car systems installed in some of Rio's *favelas*.

Seeing the city through the COR? Involving the public via social media

In addition to Facebook, Twitter and YouTube, the COR regularly uses two smart phone apps to interact with the public. The first one is Waze, a popular traffic management app owned by Google. The second is its own purposefully designed app called 'Eyes of the City', inspired by other popular apps (such as FixMyStreet) which enable direct communication between the public and local authorities. Waze, with over 6 million users in Brazil (O Globo, 2013), combines an automotive navigation system and social media. Like a traditional sat nav system, it operates by providing an overview of the city's transport network, enhanced by real time updates on traffic conditions generated via crowdsourcing. Waze maps hazards, congestion, accidents and police presence, and provides updates on the average speed of roads. Since 2013 the COR has used this pre-

existing digital platform as a way of engaging with the public. This allows Waze's users to have access to the different operational plans made by the municipality, such as road closures resulting from planned works or events, diversions and other unplanned disruptions. In exchange, the COR receives over 750,000 daily alerts logged by Waze's users, which allows it to identify and pre-screen traffic disruptions. For example, the density of Waze's alerts is used by the COR to verify the accuracy and severity of possible incidents (Prefeitura Rio de Janeiro, 2014).

Engaging with citizens via the volunteer provision of geo-referenced data has reinforced the creation of a different way of seeing and sensing the city (Goodchild, 2007; Dodge and Kitchin, 2013). In a Foucauldian way, seemingly supporting a reading of the COR as a panoptic device, using Waze represents for the COR a way of multiplying its eyes on the streets. Waze's alerts, uploaded by the public into the COR's system, illustrate the extent to which the citizen, through its ability to share real time information about urban flows, is also a functional component of the transport infrastructure being developed by the COR. At the launch of the partnership with Waze, the COR's director praised the value of crowdsource information as "an important tool for the operation of the city… The account of any occurrence outside the field of view of our cameras is a great support in targeting efforts and [provides] an improved time response to incidents" (Telesintese, 2013). In a similar fashion, the city's Chief Executive of Digital Technologies praises how, through the integration with Waze, citizens can be "100% part of the everyday life of the city… in this way we go from 650 official cameras to over 1 million cameras; the more citizens use this technology, the more agile we can be" (Interview, 2014). However, in line with Otter's (2008) critique of a reading of the history of urban vision and power as a history of discipline, this is not the panopticon

that sustains disciplinary power; rather, it is a governmental technique of visibility, as the eyes that multiply are not only those of the COR but also those of the public.

The digital reorganisation of both subjects and infrastructures and the framing of the urban as a reality in need of urgent intervention (Braun, 2014; Wakefield and Braun, 2014)—two pivotal processes within the establishment of the COR—are part of the material-spatial arrangements involved in this transformation in urban governmentalities. In transforming citizenship into citizen sensing, the public becomes a constitutive element of the emerging 'urban computational apparatus' (Gabrys, 2014). Citizen sensors' capable of monitoring environmental conditions "engage in the labour of being watched", passively collecting data whilst feeding a system beyond their control (Monahan and Mokos, 2013: 286). The public operates as a distributed perception system, expanding the capabilities of the CCTV control room. Such form of governmentality prioritises productivity and efficiency towards sustaining dominant economic logics, whilst the recasting of citizens transforms them into mere operators. In seeing the city through the COR, "the performance of smart urban citizenship occurs not by expanding the possibilities of democratically engaged citizens, but rather by delimiting the practices constitutive of citizenship" (Gabrys, 2014: 45).

4. Emergency response and the institutionalisation of permanent emergency

Four years after the rain events that marked the birth of the COR, on Monday 14th April 2014, predictions for hours of moderate yet sustained rain led to the COR to declare a state of alert for the city. From early in the morning, just as the rains started to fall, Globo TV journalists reporting from the COR were building a sense of anticipation,

providing viewers with detailed weather forecasts for the different neighbourhoods of the city. The COR's Control Room served as a background for live interviews with municipal officers and COR staff members describing the municipal response underway, alerting to the possibility of activating an early warning system in risk locations and explaining what to do in case of evacuation or floods. The broadcasts emphasised the preparedness of the city via a coordinated response: "all municipal agencies already meet today; some of us spent the night here and we are ready. The teams have been alerted" (COR's Director, as interviewed by Globo TV, April 2014).

Since the dramatic rain event of April 2010 Rio de Janeiro has taken significant steps towards preparedness and emergency response. The COR is the site from where all emergency response is to be coordinated, and the site where "all directors of key agencies go to… take decisions", explains the director of the city's Civil Defence (Interview, 2014). In 2011 the municipality prepared a detailed plan of areas prone to landslides alongside an emergency plan for extreme rain events, the PEM-Rio (Prefeitura Rio de Janeiro, 2011). A municipally owned meteorological radar now provides images to the cities own weather agency—*Alerta Rio*, headquartered at the COR—as well as up-to-the-minute information on the location and intensity of precipitation over the city. This is complemented with satellite imagery as well data generated by a network of over 130 rain gauges spread across the city and connected to the COR. The city's strategy for emergency response draws heavily on community involvement, particularly in the many *favelas* located in areas prone landslides. The Civil Defence sends blanket SMS messages to all registered users alerting them on risky weather conditions as well as targeted messages to community leaders and volunteers with requests to organise and prepare their communities. The Civil Defence has established a Community Alert and Alarm System, a network of community leaders and

volunteers trained to support evacuation efforts (known as *NUDEC*) and an early warning system based on sirens currently available in 101 at-risk communities.

Over the course of the following 48 hours Globo TV, radio broadcasters and the COR were in constant contact with the public, reporting on an hourly basis the changing weather conditions of the city. Viewers were constantly reminded that the city was in a state of alert, yet through a message that portrayed a situation under close monitoring and control. The public were provided with a clear understanding of both the city's vulnerability and how this broad infrastructural system of emergency response operated. By Tuesday morning news anchors were reporting on the disruptions caused by the rain—road accidents, fallen trees, localised flooding—and the almost immediate response of municipal agencies towards restoring the city to normal. News anchors would make constant references to the COR as the site from where the emergency was being managed, and TV interviews with COR staff focused on detailed weather predictions and information on which areas of the city where at highest risk. Citizens were urged to stay alert, and those living in high-risk areas were asked to prepare for the possibility of evacuation. Using digital mapping techniques and three dimensional renderings of the city, news anchors described in detail the city's ecological conditions (current and future weather patterns) as well as the infrastructural tools used to develop such knowledge—the network of pluviometric stations distributed across the city and the functioning of rain gauges. On that occasion, after hours of deliberation and in order to avoid affecting the credibility of the COR within the public, it was decided not to proceed with an evacuation.

Echoing the work of Grusin (2010), where a sense of anticipation is inbuilt in contemporary media operations, the mediated viewing of both the COR and Rio's infrastructure modulates the public's attention, anticipates the event through a state of

alert and builds everyday expectations ahead of the emergency. This 'mediality', concerned with modulating the public's affect and aimed at generating a response, acts as a technology of government. Within the COR, the everyday is seen in a state of permanent emergency; urgency the paradigm driving action. The focus is always the moment and the objective an immediate response. For staff members, working at the COR is a constant exercise in solving problems in as close as possible to real time. "We work very much on top of what is happening at the moment!" explains a COR directive; "it is a daily exercise in how to solve problems" (Interview, 2014). Framing urban flows as a matter of civic rights, the COR's focus is maintaining the city flowing; its movement; its circulations. Even when the disruption itself is political, such as with the anti-World Cup demonstrations, maintaining the flow as an operational requirement takes precedence over the very politics that are being made manifest. "We don't want to get into the issues of the demonstrators, whether they're right or wrong," says the COR director in an interview with The Guardian (2014); "for us it's about the rest of the city being able to maintain their routines. We communicate the situation to citizens, and keep the city flowing around the interruption".

The emergency response capabilities, applied to the everyday, rest on a preparedness based on specific forms of logistical control, forecasting and anticipating abilities at municipal level which in this case are applied specifically to the interface between urban conditions, flows and the city's ecological cycles. This is a logic that extends beyond the COR and applies to the broader emergency response systems of the city: a logic of preparedness is inbuilt within the population via community training programmes, evacuation simulations and mobile communications. The integration of the public as a functional component of the infrastructure also occurs through the deployment of technologies of visibility, enabled by ICT and media involvement,

narratives on transparency, and the generation of new viewpoints. New media such as Facebook, Twitter and smartphone apps establish bi-directional communication between the COR and the public, providing a constant stream of information back to the COR. Laying out a particular understanding of the city as a space of logistical operations, the COR reduces city to a set of procedural steps within a contained and manageable environment. "The city is a building with six million inhabitants" says the COR's Director of Operations, referring to the critical role played by his—highly experienced in operations and logistical systems—staff; "if you know about operations, you will adjust to [operate] here" (Interview, 2014).

5. Conclusion

Rio's COR, as a global template for an emerging digital urbanism, is piloting a particular 'exemplar' approaches to urban integration and control—influencing other cities, from Curitiba (Prefeitura de Curitiba, 2015) to Glasgow (Financial Times, 2014)—whilst advancing technologically-based models of urban resilience (see Rockefeller Foundation, n.d.). It denotes an emergent regime of urban governmentality based on the transmutation of technologies, techniques and rationalities previously developed for corporate and logistics sectors. The COR generates new understandings of the city, representing a new mode of urban infrastructure largely based on the partial and selective rebundling of networks and urban space. There are two underlying spatial logics that the COR seeks to integrate. The first is a network logic of logistical control, originally developed in the context of software packages for corporate management and integration and further expanded within the logistics sector, particularly within

aviation, transportation, freight, distribution and logistics industries (Cowan, 2014). These systems are designed to provide real-time, efficient and effective circulatory flow under conditions of disruption—political unrest, delay/congestion, weather conditions and technological failure. They embody governing dimensions, characterised by reducing agency to procedural effects and cross-functional transactions (Kallinikos, 2004). The second is the nodal logic of the control room, more present in the control of commercial spaces—sports stadia, shopping centres, and office complexes. This provides a form of territorial control with a mix of flow, safety, maintenance and incident control. What the COR represents is a coming together of these network (the infrastructure that commands flows) and territorial (the node of control) logics in a new set of techniques and practices of flow maintenance. Such horizontal extension of network and nodal logics across urban infrastructures represents a particular form of 'operational' rebundling aimed at guaranteeing flow maintenance under many different conditions. The extension of such control room logic to the totality of the city is a first step in the un-black boxing of infrastructures. Here a (metropolitan) control room, as an ongoing practical accomplishment (Gordon, 2012), reveals functions and operations in the everyday. The COR, as both a control room and a large system of systems, reveals the fragility of these systems, their unstable nature and the extent to which they require constant work in order to deliver services.

The COR is also distinctive in how it seeks to integrate different modes and rhythms of control that are often separated in conventional typologies of control rooms: the maintenance of everyday operation and the challenges of dealing with exceptional situations in response to particular emergencies. It seeks to combine continuous and pervasive 24 hour monitoring of infrastructural network conditions *and* develop intermittent—discontinuous—responses to 'events', both planned and unplanned, for

which special control measures need to be applied. The collapse between different modes of network control is a decisive feature that further contributes to an infrastructural un-black boxing, particularly through the close coupling between crises and the everyday. This occurs both within the COR itself, where every event, however small, needs to be monitored, and through the COR's representation in the media.

This signals a departure from dominant forms of infrastructural configuration, problematizing our understanding of infrastructure as splintered, stable and 'black boxed' (Graham and Marvin, 2001). It points to a different form of governmentality, based on the operationalisation of infrastructural flows and the development of novel ways of seeing and engaging with the city. A collapse in relations of control (of the everyday and the emergency) and the transformation of forms of engagement with the public (where the public does no longer operate as the final receiving end-point of the infrastructure network but as an essential functional or operational element) leads to enhanced levels of awareness of infrastructure amongst the public. New logics of transparency and visibility, alongside the generation of new viewpoints for understanding the city, denote a different set of capacities and ways of doing.

Although we argue that smart rationalities are progressively transforming the black boxed nature of urban infrastructures, it is important to note that this un-black boxing differs from emerging forms of infrastructural 'white boxing' where open source platforms actively empower citizens to change operational systems (Corsín Jiménez, 2014). Contrary to that, as this emerging form of computational urbanism 'un-black boxes' infrastructure, new forms of digital black boxing emerge whilst the very transparency provided by mediatized infrastructures creates new invisibilities. As the COR directs the city's gaze to particular urban sites, other sites—both digital and non-digital—go unseen. Social and political analyses of the digitalization of the everyday

point to algorithms (a digital calculative device) as an emerging form of 'black boxing', characterised by an ability to develop new epistemologies, forms of social ordering and inaccessible decision-making procedures (Rouvroy, 2012; Gillespie, 2014). In this sense, the un-black boxing of the city's infrastructures is only partial. Such novel digital and mediatised infrastructural condition begs asking questions around the rationalities and emerging modes of black boxing that underpin these new forms of urban control, and the forms and types of publics that engage with it (e.g. whether the new smart Rio works for all or a few, particularly in the context a global South city where infrastructures historically have been experienced in differential ways by different publics, functioning for some whilst operating in a permanent state of disrepair for others). Is the metropolitan control room, by providing an illusion of movement and action, being used materially and discursively to side-step attention from critically required interventions? Is emergency being positioned as a mode of urban existence and, in line with Collier and Lakoff (2014), preparedness a mode of urban governance? Is infrastructural coding—now playing a ubiquitous role the making of the city (Kitchin and Dodge, 2011)—the new shape of urban black boxing? In the case of Rio, such re-black boxing appears to come through the embeddedness of digital and corporate rationalities that rest on embracing perpetual emergency and are now essential for the maintenance of urban circulation.

In developing new ways of experiencing the city, and in un-black boxing infrastructures, the COR brings about an operationalisation of the urban; a direct response to what Foucault termed the primary problem of the city—one of circulation. What is at stake is the ability of the city to secure the required exchanges for the reproduction and maintenance of its economy (Foucault, 2007). If maintaining flow is seen as an ideal form of urban operation, it is important to recognise that the priority flow is not only

the material flow of resources (waste, traffic, water, power, etcetera), but also the configuration of information as a key urban resource—one that also needs to keep flowing. Constant information flow is the new nature of the city; the milieu that has to be created. In a world increasingly governed through a collapse between infrastructure and the environment, where natural processes are not to be stopped but allowed to occur (Braun, 2014), the COR naturalises flow and through this the urban imperative of efficiency and productivity. Braun draws on Agamben (2009) to argue that these new urban apparatuses—from resilience urbanism to the smart city—"represent the 'eclipse of politics', that is, the triumph of 'oikonomia' or 'management' as a pure activity of government that aims at nothing other than its own replication" (Braun, 2014: 61). The form of governmentality established by the COR, where the city is managed like a logistical enterprise, does not question established orders. Instead, it seeks to ensure their maintenance without changing organisation, ownership or orientation. In being offered the viewpoint of the control room, the citizen, rather than a political subject, becomes an operational component of the infrastructure

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